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EDITORIAL.

Guinea Grass As A Fodder

The provision of suitable fodder at an economic cost has constituted one of the more important limiting factors in cattle-keeping in Malaya. The common practice amongst the Indian cattle-keepers, who form the majority of those actively engaged in this industry, is to grass-feed their animals on such pasturage as may be found on the way-sides and on unoccupied land near the larger centres of population. Such pasturage is usually supplemented by stall-fed fresh grass and concentrated food.

The quantity of the cut grass is limited, and the pasturage is often of poor quality: so long as these remain the main foods there is little likelihood of any appreciable advance in this Malayan industry.

In recognition of this position, experiments were laid down some years ago at the Central Experiment Station, Serdang, to discover which of the known fodder grasses was suitable to local conditions. Of the large number of grasses tried, Guinea grass (*Panicum maximum*) was found to be the most suitable.

Although small test plots, grown under ideal conditions, were successful, it did not follow that the cultivation of this grass on a commercial scale, in situations such as were likely to obtain in practice, would be so successful as to justify the Department in recommending the grass for general cultivation. For this reason, the experiments which form the subject of the article in this number were carried out. These results, therefore, are of very practical value and for this reason it is pertinent to examine the conclusions reached.

On both "light" and "heavy" soils, the yield of grass decreases with the age of the grass "stools." It follows, therefore, that it is necessary to limit the frequency of grass-cutting, and every three to four years to replant the area after cultivation and manuring. Three-weekly cutting gives a higher annual yield than fortnightly, four-weekly a little more than three-weekly, but four, five and six-weekly cuttings all give a similar yield. Quality decreases with increasing interval but not greatly unless the interval exceeds four weeks. Thus four-weekly cuttings give maximum yield and a fair quality fodder.

Further experiments on the re-planting of areas with Guinea grass established the fact that cattle manure at the rate of from 10 to 15 tons per acre per annum is essential if even moderate yields are to be maintained.

Even with manuring, the yields of grass have been appreciably lower than those usually quoted for this grass, but they are sufficiently high to justify stall feeding with Guinea grass instead of pasturage. On the type of soil normally used for cattle keeping in Malaya stocking at the rate of $1\frac{1}{2}$ cows to 2 cows per acre is a reasonable estimate if the area is planted with Guinea grass, whereas if the same area was used for pasturage several acres would be required to support one cow.

We have not, in this place, attempted to give more than a broad indication of the conclusions reached as a result of this work. The investigations have dealt with the subject from many angles, such as spacing of the plants, nutritive value of the grass under different conditions—of soil, age of plants, manuring and frequency of cutting. Such points as these are of importance and the detailed information given in the article will repay close study.

The value of fresh milk in the maintenance of health has of recent years been widely acknowledged and considerable propaganda has been directed to influence public opinion on this subject. The desirability of increasing the consumption of fresh milk in Malaya has perhaps been accorded less publicity, but the need is equally as great as elsewhere. The conclusions reached as a result of the experimental work, described in this place, should be of great value in any efforts made to increase the production in Malaya of fresh milk.

Original Articles.

EXPERIMENTS WITH GUINEA GRASS AT THE CENTRAL EXPERIMENT STATION, SERDANG.

Compiled from records of the Agricultural and Chemical Divisions.

Introductory.

The desirability of fodder grasses for cattle has long been recognized in Malaya. Comparative tests with a considerable number of fodder grasses were conducted early in the history of the Central Experiment Station, Serdang, and in 1924 it was stated that, of these, Guinea grass had been found to be the most desirable—yields of 40 tons per acre per annum were obtained on flat virgin soil. In the article quoted the desirability of choosing damp places was emphasized.*

Dairies should be situated as close to towns as possible, in order to reduce transport costs to the minimum, but it is now a difficult matter to find virgin land of any extent around the larger Malayan towns and still more difficult to find flat areas of such land. In 1932, the first of two experiments was therefore started at the Central Experiment Station, Serdang, to test productivity on cropped soil, not especially flat, nor especially damp.

This experiment was also designed to answer a number of other questions, of which the most important were those of necessary manurial applications and quality of grass.

Early high yields at Serdang were obtained by liberal use of cattle manure (of the order of 20 tons per acre per annum) but in practice, grass must be grown and be ready for cropping before a herd is established; unless a sufficient yield can be obtained without manure, artificial fertilizers must be employed to start the area, since purchase of cattle manure would be uneconomic in Malaya. Similarly, if an existing herd is to be appreciably enlarged, an extended area of fodder grass must be brought into cropping and application of cattle manure to either the new or old area, or to both, must be reduced from a high level during the process.

To test these points the trials included treatments with artificial fertilizers, of varying degrees of complexity and cost, and with cattle manure at the rate of 10,000 lbs. per acre (approximately 5 tons instead of the 10 or 20 tons which might normally be expected for a herd and area in being). Two further, but minor, considerations aided in the fixing of the application at 10,000 lbs: (a) this quantity contains phosphoric acid roughly equal in amount to that supplied by the fertilizer mixtures employed and (b) if reduced quantities of cattle manure were in practice found sufficient there would be (near towns) a highly profitable outlet for surplus manure for market gardening.

As quality, that is, nutritive value of fodder, is as important as quantity, arrangements were made for chemical analyses of the grass.†

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* *Malayan Agricultural Journal*, Vol. XII, p. 394.

† For details of sampling and analysis see Appendix A.

As interval of cutting may affect both quality and quantity, three frequencies were tested, cuttings being made at one week, fortnightly and three-weekly intervals.

Lay-out of Experimental Plots.

Since the inception of the experimental work in 1932 fertilizer applications and intervals of cutting have been varied, but the lay-out of the plots has remained unaltered as originally described in this Journal(1).

The lay-out is shown in Diagram 1 and provides for four replications of eight manurial treatments (including an unmanured control) on sub-plots of 1/60th acre each with different cutting frequencies. The total area under each manurial treatment is thus 1/15th acre.

The experiment was duplicated on 'heavy' and 'light' soils. These names are relative, as the former does not represent the truly heavy soils of Malaya.

Soil analyses are given in Table I; unfortunately analyses were not carried out in 1932 but in 1937. It is unlikely, however, that there have been any serious changes in physical composition or 'total' nutrients during the five-year period.

The 'heavy' area is slightly sloping, the slope running diagonally across the plot. The land had been planted with croton, *Croton Tiglium*, for 10 years. There had been some soil wash before the experiment started.

The 'light' area is flat and had originally (1923) been planted with limes, *Citrus medica* var. *acida*, but these made poor growth and were removed in 1929. Since then the area had been developed as rough pasture.

Both soils are poor in potash and the 'light' soil is exceptionally poor in phosphoric acid.

Planting and Cultivation.

The areas were enclosed with wire fencing and ploughed to a depth of 6 inches. Later, the ground was lightly cultivated and levelled to obtain an even surface for planting.

Both areas were planted in March, 1932, the stools of grass being spaced at intervals of 2 ft. x 2 ft., square planting.

In order to confine the manurial dressing applied to an individual plot the following precautions were taken:—

"Heavy" Soil. Owing to the land being on a slight slope, silts pits, 1 ft. wide and 1 ft. deep, were dug along the length of the series of plots, No. 8, No. 1, No. 4 and No. 8, bordering on the upper edge of the main path running through the area. No silt pit was dug, however, on the other side of the path, its place being taken by a guard row (see Diagram I).

The soil from the silt-pits is thrown back periodically on the slope above the row of pits.

"Light" Soil. In view of the flat nature of the area, silt-pits were considered unnecessary, guard rows running length-wise between each series of plots being substituted in all cases.

Table I.
Analysis of Soils under Experiment.

A. Physical Analysis.

Percentage Composition.

	Clay	Silt	Fine Sand	Coarse Sand	Gravel	Loss on Ignition	pH
Experiment I.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	
"Heavy" Soil. Topsoil ...	48	9	29	14	Nil	9	4.8
Subsoil ...	43	10	37	10	Nil	9	4.8
"Light" Soil. Topsoil ...	11	9	46	31	1	3	5.0
Subsoil ...	14	6	46	30	1	3	5.2
Experiment II.							
Topsoil ...	46	14	30	8	Nil	9	4.8
Subsoil ...	40	16	33	11	Nil	7	4.8

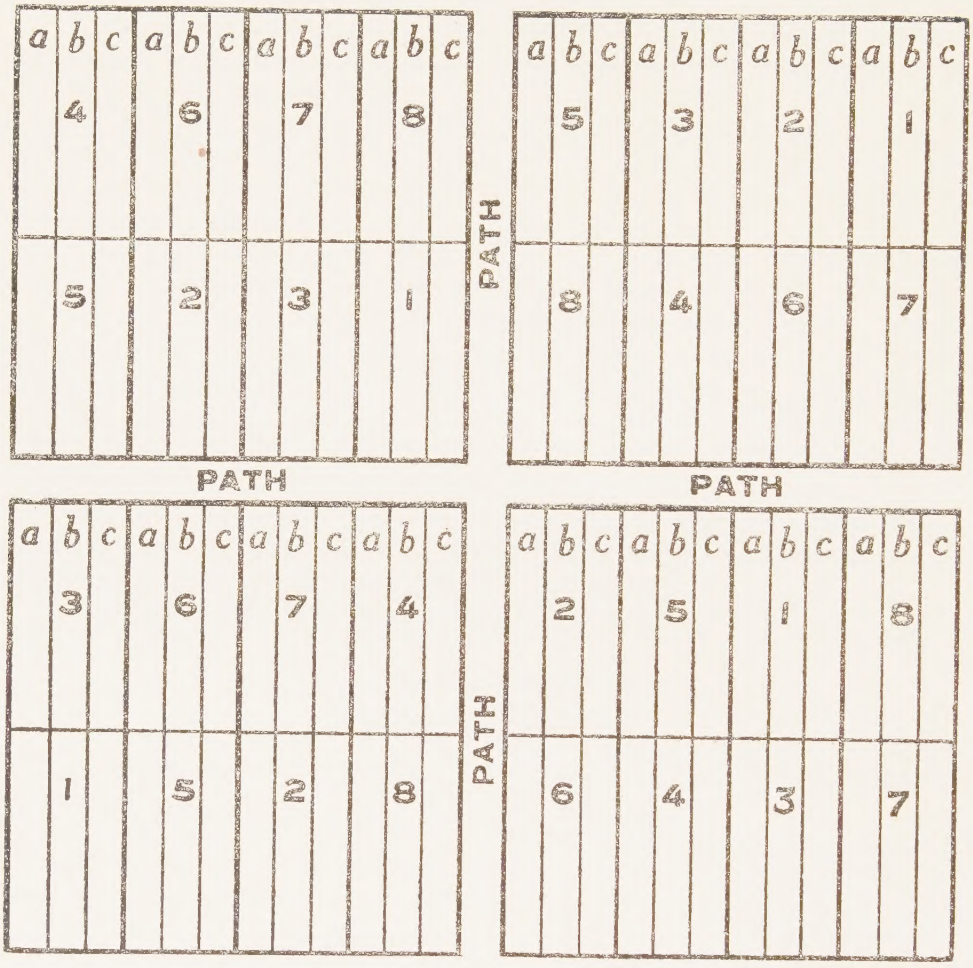
B. Chemical Analysis.

Percentage Composition.

	Nitrogen	CaO	Fe_2O_3, Al_2O_3	K_2O	P_2O_5
Experiment I.	per cent.	per cent.	per cent.	per cent.	per cent.
"Heavy" Soil. Topsoil ...	0.086	0.030	19.8	0.166	0.022
Subsoil ...	0.078	0.032	21.0	0.208	0.020
"Light" Soil. Topsoil ...	0.091	0.039	5.4	0.061	0.006
Subsoil ...	0.050	0.044	5.5	0.089	0.009
Experiment II.					
Topsoil ...	0.120	0.089	14.0	0.294	0.033
Subsoil ...	0.081	0.056	16.3	0.343	0.024

DIAGRAM I.

Arrangement of Plots in Manurial Experiment with Guinea Grass.



Notes:

1. The numbers of the plots correspond to the different manurial treatments.
2. Each plot is trisected into three sub-plots, lettered "a", "b" and "c" respectively. These were cut at different intervals.
3. In the first phase the cutting programme was as follows :—
   (a) Sub-plots lettered "a" were cut weekly, then monthly and finally three-weekly.
   (b) Sub-plots lettered "b" were cut fortnightly.
   (c) Sub-plots lettered "c" were cut three-weekly.
4. In the second phase the cutting programme was as follows :—
   (a) Sub-plots lettered "a" were cut four-weekly.
   (b) Sub-plots lettered "b" were cut five-weekly.
   (c) Sub-plots lettered "c" were cut six-weekly.

All the plots were weeded periodically with a changkol (hoe) to a depth of about $\frac{1}{2}$ inch; no inter-row cultivation was given. The experiment was conducted in two phases, to test shorter and longer intervals of cutting.

First Phase. Shorter Intervals of Cutting.

Manurial treatments employed are given in Table II. Malayan inland soils are known to be especially deficient in, and to respond to, phosphoric acid; this nutrient was therefore used in all the treatments with artificial fertilizer.

Both 'acid' and 'basic' treatments were employed, because considerable differences of response to the two classes of fertilizer by annual crops had been found on similar soils.

Cutting was started in December, 1932 and continued until June, 1934. Cutting intervals on the "a" sub-plots were, however, twice changed, weekly cuttings being employed from December, 1932 to March, 1933, monthly from April, 1933 to September, 1933 and three-weekly from September, 1933 to June, 1934, with a change of manurial treatments for the last period. These changes were exploratory in character and revealed no differences of importance in composition from the sub-plots cut less frequently. Weekly cutting proved to be far too severe and yielded less than half the grass harvested from the "b" and "c" sub-plots, which were cut at fortnightly and three-weekly intervals respectively.

On the "b" and "c" sub-plots cutting intervals were maintained unchanged and there was only one minor change of manurial treatment; it is proposed, therefore, to give results from these plots only and to discard those from the "a" sub-plots on which there was lack of continuity.

A. Yields of Grass.

The figures for the average yields of grass on the two types of soil for three periods cut at fortnightly and three-weekly intervals are shown in Table III, Parts I and II respectively.* Figures for May and June, 1933, have been omitted. In the former month there were errors of omission of cutting which may have affected yields in June. Part I of the table gives the figures for the grass on the 'heavy' soil, Part II those for the 'light' soil. The figures have been calculated in lbs. of grass per acre per day.

The most striking feature of these yields is the rapid fall from the moderate standard attained on manured plots in the first six months, and the fact that the second application of manure had no beneficial action on the grass. Assuming that 45 lbs. of grass per day is needed for one cow, indications are that allowance must be made for 1 acre per cow on 'heavy' soil and about $1\frac{1}{2}$ acres per cow on 'light' soil, if the grass is to be cut fortnightly or three-weekly.

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* It will be noticed that mean yields for the 18 months' period have not been given. In view of the large differences between the first and the two later periods, it is felt that general means would be misleading and meaningless.

Table II.

Manurial Treatments for Guinea Grass at Serdang.

Experiment I, First Phase.

Serial No.	Details of Manure	Rate of Application (lbs. per acre per annum)[1]			
		July — August 1932 "Heavy" and "Light" Soil.	August 1933.		
			"Heavy" Soil[2]	"Light" Soil[2]	
1	Basic slag ...	750 (120 lbs. P_2O_5)	As in July-August 1932, except that nitrogenous fertilizers were applied in three equal parts at four-monthly intervals. The first application was made in August 1933.	750 (120 lbs. P_2O_5)	Nitrogenous fertilizers were applied in instalments as on "heavy" soil.
2	Superphosphate of lime ...	750 (120 lbs. P_2O_5)		750 (120 lbs. P_2O_5)	
3	Calcium cyanamide ... Basic slag ...	210 (40 lbs. N) 750 (120 lbs. P_2O_5)		262.5 (50 lbs. N) 750 (120 lbs. P_2O_5)	
4	Sulphate of ammonia ... Superphosphate of lime ...	200 (40 lbs. N) 750 (120 lbs. P_2O_5)		250 (50 lbs. N) 750 (120 lbs. P_2O_5)	
5	Calcium cyanamide ... Basic slag ... Sulphate of potash ...	210 (40 lbs. N) 750 (120 lbs. P_2O_5) 167 (80 lbs. K_2O)		262.5 (50 lbs. N) 750 (120 lbs. P_2O_5) 167 (80 lbs. K_2O)	
6	Sulphate of ammonia ... Superphosphate of lime ... Sulphate of potash ...	200 (40 lbs. N) 750 (120 lbs. P_2O_5) 167 (80 lbs. K_2O)		250 (50 lbs. N) 750 (120 lbs. P_2O_5) 167 (80 lbs. K_2O)	
7	Cattle manure ...	10,000 (67 lbs. N) (120 lbs. P_2O_5) (32 lbs. K_2O)		12,500 (84 lbs. N) (150 lbs. P_2O_5) (40 lbs. K_2O)	
8	Control ...	No manure.		No manure.	

[1]The approximate amounts of nitrogen (N), phosphoric acid (P_2O_5) and potash (K_2O) corresponding to the different amounts of fertilizers are shown in brackets.

[2]These applications were made only to "b" and "c" sub-plots; "a" sub-plots received different treatment, but the yields from the plots have been disregarded in this paper.

Turning to details it will be noticed that—

(i) There has been a different degree of response to the two intervals of cutting on the two areas, the longer interval having given significantly better yields on the 'heavy' soil, while on the 'light' soil the difference though consistently in the same direction is too small to be statistically significant.

Table III, Part I

"Heavy" Soil.

Average Yields of Guinea Grass at Serdang cut at fortnightly and three-weekly intervals, December 1932 to June, 1934.

(Results calculated in lbs. of grass per acre per day.)

Serial No.	Manurial Treatment	First period Dec. 1932-Ap. 1933		Second period July-Dec. 1933		Third period Jan.-June 1934	
		Fortnightly interval	Three-weekly interval	Fortnightly interval	Three-weekly interval	Fortnightly interval	Three-weekly interval
1	Basic slag ...	116	135	45	56	39	48
2	Superphosphate of lime ...	66	90	51	65	52	60
3	Calcium cyanamide ... Basic slag ...	116	116	44	58	37	46
4	Sulphate of ammonia ... Superphosphate of lime ...	101	118	46	65	38	51
5	Calcium cyanamide ... Basic slag ... Sulphate of potash ...	116	126	55	68	47	52
6	Sulphate of ammonia ... Superphosphate of lime ... Sulphate of potash ...	113	142	64	68	54	61
7	Cattle manure ...	96	110	47	44	40	45
8	Control ...	68	82	31	42	22	30
	Means ...	99	115	47	58	41	49
		107		53		45	
Significant Difference for mean of Cuttings	(9 :1)	9		4		4	
	(19 :1)	10		5		5	
Significant Difference for Manurial Treatments' 'within' Cuttings	(9 :1)	24		12		10	
	(19 :1)	30		15		13	

Table III, Part II.

"Light" Soil.

Average Yields of Guinea Grass at Serdang cut at fortnightly and three-weekly intervals, December 1932 to April 1934.

(Results calculated in lbs. of grass per acre per day)

Serial No.	Manurial Treatment	First period Dec. 1932-Ap. 1933		Second period July-Dec. 1933		Third period Jan.-June 1934	
		Fortnightly interval	Three-weekly interval	Fortnightly interval	Three-weekly interval	Fortnightly interval	Three-weekly interval
1	Basic slag ...	67	72	39	39	29	30
2	Superphosphate of lime ...	62	69	42	39	29	26
3	Calcium cyanamide ... Basic slag ...	69	82	41	47	33	33
4	Sulphate of ammonia ... Superphosphate of lime ...	60	65	44	41	28	30
5	Calcium cyanamide ... Basic slag ... Sulphate of potash ...	72	83	48	44	37	36
6	Sulphate of ammonia ... Superphosphate of lime ... Sulphate of potash ...	75	91	54	47	38	35
7	Cattle manure ...	69	68	41	41	36	32
8	Control ...	45	51	24	32	19	17
	Means ...	65	73	42	41	31	30
		69		42		30	
Significant Difference for mean of Cuttings	(10 :1)	8		Obviously no significant difference.		Obviously no significant difference.	
	(20 :1)	10					
Significant Difference for Manurial Treatments 'within' Cuttings	(10 :1)	13		8		6	
	(20 :1)	18		12		8	

(ii) On both soils there was significant response to all manuring, except for the curious case of superphosphate of lime on the 'heavy' soil during the first six months. Phosphoric acid was clearly essential, but the addition of nitrogen (Treatments 3 and 4) produced no additional yield. It is impossible to say whether

Effect of Rainfall on Yield of Guinea Grass Planted on Heavy Soil and Cut at Three-Weekly Intervals.

Reference No. of Graph	*Details of Manure*
No. 1	Basic Slag
No. 2	Sulphate of Ammonia Superphosphate of Lime Sulphate of Potash
No. 3	Superphosphate of Lime
No. 4	Cattle Manure

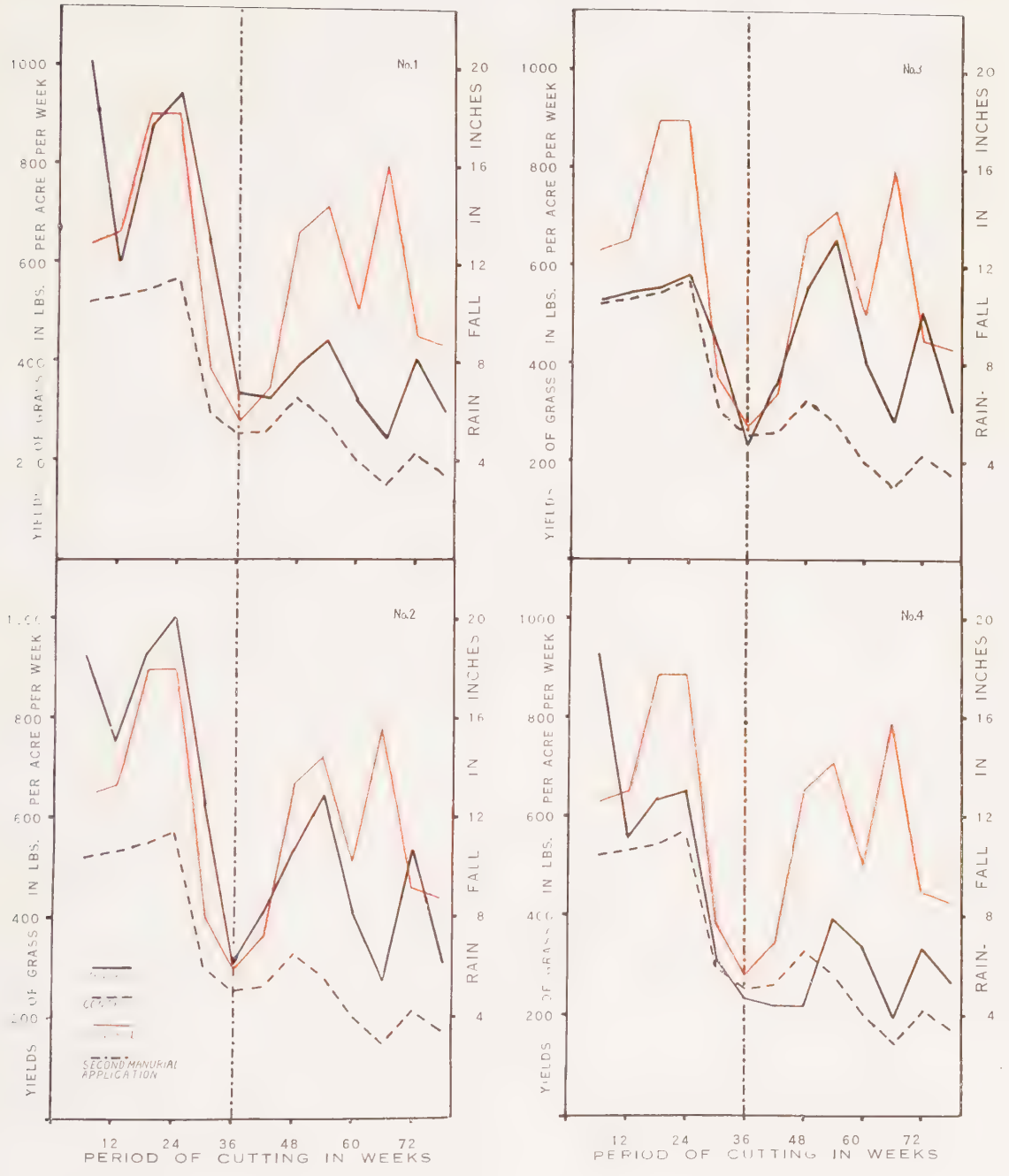
The rates of application of the manures are shown in Table II.

PLATE I

Effect of Rainfall on Yield of *Guinea* Grass Planted on Heavy Soil and Cut at Three-Weekly Intervals.

Reference No. of Graph	Details of Manure
No. 1	Basic Slag
No. 2	Sulphate of Ammonia Superphosphate of Lime Sulphate of Potash
No. 3	Superphosphate of Lime
No. 4	Cattle Manure

The rates of application of the manures are shown in Table II.


No.1
No.3
No.2
No.4
1000
800
600
400
200
20
16
12
8
4
RAIN FALL IN INCHES
PER ACRE PER WEEK
IN LBS.
OF GRASS
YIELDS
12
24
36
48
60
72
PERIOD OF CUTTING IN WEEKS
SECOND MANURIAL APPLICATION

Effect of Rainfall on Yield of Guinea Grass Planted on Light Soil and Cut at Three-Weekly Intervals.

Reference No. of Graph	*Details of Manure*
No. 1	Basic Slag
No. 2	Sulphate of Ammonia Superphosphate of Lime Sulphate of Potash
No. 3	Superphosphate of Lime
No. 4	Cattle Manure

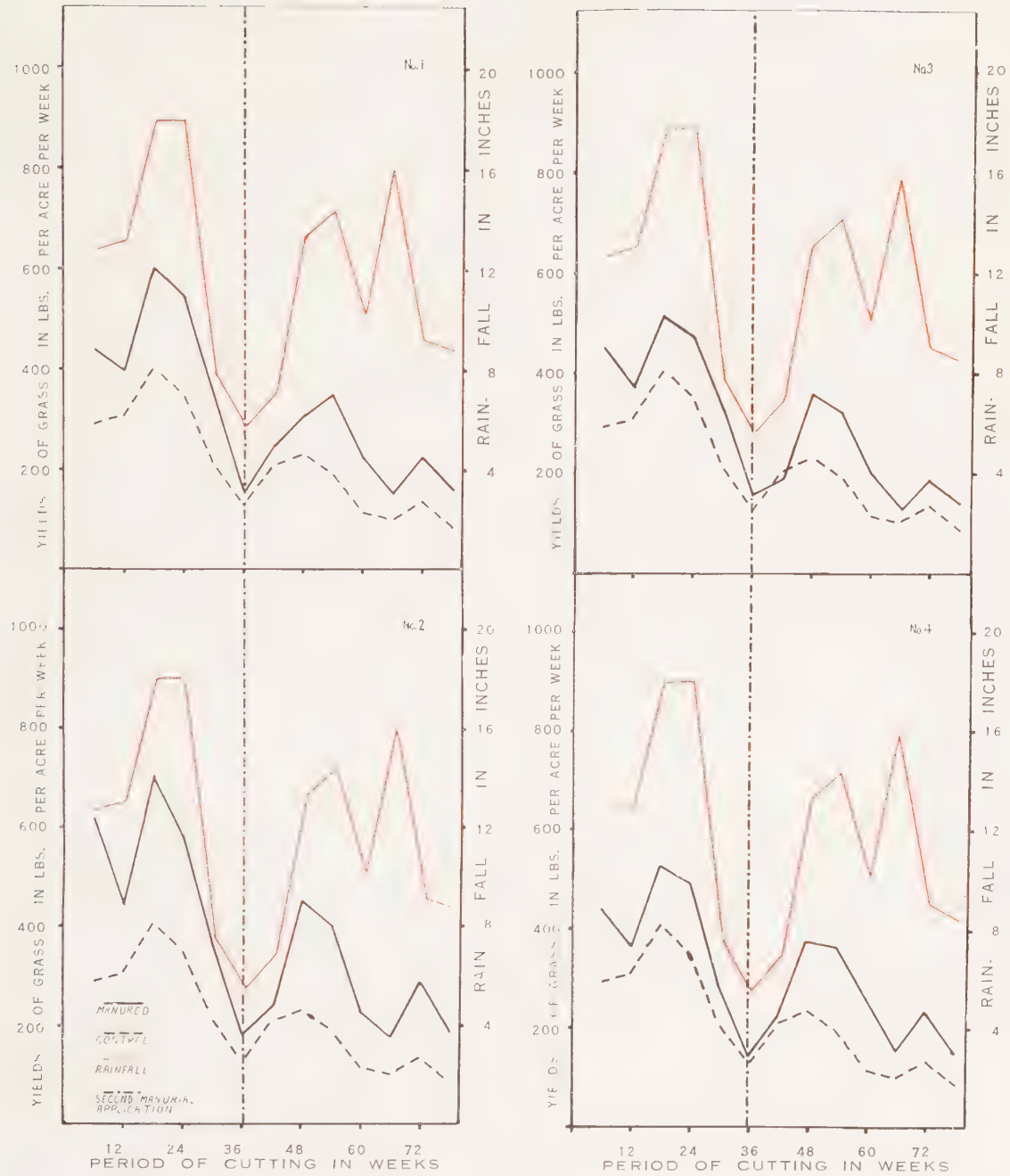
The rates of application of the manures are shown in Table II.

Effect of Rainfall on Yield of Guinea Grass Planted on Light Soil and Cut at Three-Weekly Intervals.

Reference No. of Graph	Details of Manure
No. 1	Basic Slag
No. 2	Sulphate of Ammonia Superphosphate of Lime Sulphate of Potash
No. 3	Superphosphate of Lime
No. 4	Cattle Manure

The rates of application of the manures are shown in Table II.

PLATE II.


No.1
No.2
No.3
No.4
YIELDS OF GRASS IN LBS. PER ACRE PER WEEK
RAIN-FALL IN INCHES
1000
800
600
400
200
20
16
12
8
4
MANURED
CONTROL
RAINFALL
SECOND MANURIAL APPLICATION
12 24 36 48 60 72
PERIOD OF CUTTING IN WEEKS

the significantly high yields of the complete mixtures, No. 6 on the 'heavy' soil and Nos. 5 and 6 on the 'light' soil, would have been produced in the absence of nitrogen, but it is clear that the increased yields although significant are not sufficiently great to render the relatively expensive nitrogenous and potassic manures economic.

Cattle manure in the quantity applied in the earlier stages of the experiment was definitely inferior to some of the inorganic mixtures and clearly has no specific effect on Guinea grass in these areas.

B. Effect of Rainfall on Yields of Grass.

The influence of rainfall on yield is illustrated graphically in Plates I and II, in which the average yields for three-weekly cuttings and certain manurial treatments on both types of soil have been plotted against rainfall for six-weekly periods.

There is a fairly close correlation for both types of soil between yield and rainfall in the early stages of the experiment, but this becomes less marked in later stages.

C. Quality of Grass.

The quality of the grass will be considered in relation to each constituent.

(a) *Moisture.*—The moisture content tended to vary slightly with the prevailing weather, also with the age of the stools. When cutting started (December, 1932) the moisture content of the grass was approximately 79 per cent. During the dry season (June-August, 1933) the figure fell to about 75 per cent., increasing to about 77 per cent. with the next wet season (October-December, 1933). There is still, however, a diminution of 2 per cent. compared with the original figure.

There were no marked differences between the moisture content figures for grass cut at either fortnightly or three-weekly intervals, while the type of soil was also apparently without effect in this respect.

(b) *Crude Protein.*—The results of the determinations may be summarized as follows:—

(i) Manurial treatment has little effect, if any, on the crude protein content of the grass on either type of soil. Table IV shows the range of variation obtained with one series of samples for one three-monthly cutting period, including both intervals of cutting on the two types of soil.

The figures indicate that the crude protein contents are of the same order for the fortnightly cutting on both types of soil and the three-weekly cutting on the 'heavy' soil. The range of figures for the grass on the 'light' soil cut at three-weekly intervals is, however, much lower.

(ii) Table V illustrates the tendency for the protein content to decrease with an increase in age of stools. This tendency is particularly marked with the grass having a high initial crude protein content, for example, the grass cut at fortnightly

intervals on both types of soil and at three-weekly intervals on the 'heavy' soil. Further, the crude protein content does not increase following the application of a manurial dressing.

(c) *Crude Fibre.*—The results of analysis indicate that neither the manurial treatment nor the type of soil has any significant effect on the crude fibre content of the grass. There is, however, a tendency for the crude fibre content to increase slightly with an increase in the interval of cutting. Figures for one series of samples for one three-monthly cutting period, including both types of soil and intervals of cutting, are given in Table VI.

There was no tendency for the crude fibre content to vary with an increase in the age of the stools.

Table IV.

Variations in Crude Protein Content of Guinea Grass with Different Manurial Treatments.

(Moisture-free basis.)

Serial No.	Details of Manurial Treatment.	Fortnightly Cutting		Three-Weekly Cutting	
		"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil
		per cent.	per cent.	per cent.	per cent.
1	Basic slag ...	18.0	16.3	16.6	12.2
2	Superphosphate of lime ...	14.5	17.1	15.2	12.0
3	Calcium cyanamide ... Basic slag ...	17.2	16.8	17.0	12.2
4	Sulphate of ammonia ... Superphosphate of lime ...	15.4	16.5	16.5	12.7
5	Calcium cyanamide ... Basic slag ... Sulphate of potash ...	18.1	17.4	15.9	12.7
6	Sulphate of ammonia ... Superphosphate of lime .. Sulphate of potash ...	16.2	16.5	15.4	13.6
7	Cattle manure ...	16.5	16.4	16.1	13.7
8	Control ...	15.7	18.0	15.1	12.6
	Maximum ...	18.1	18.0	17.0	13.7
	Minimum ...	14.5	16.3	15.1	12.0
	Average ..	16.5	16.9	16.0	12.7

Table V.

Decrease in Crude Protein Content of Guinea Grass with Increase in Age of Stools.

(Moisture-free basis.)

Serial No. of Three-Monthly Cutting Period.	Fortnightly Cutting.		Three-Weekly Cutting.	
	"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil
	per cent.	per cent.	per cent.	per cent.
1 ...	16.5	16.9	16.0	12.7
2 ...	14.4	13.5	12.7	12.1
3* ...	14.1	13.0	13.2	11.6
4 ...	12.5	12.4	12.3	11.5

* Manure applied during this cutting period.

Table VI.

Variations in Crude Fibre Content of Guinea Grass with Different Manurial Treatments.

(Moisture-free basis.)

Serial No.	Details of Manurial Treatment	Fortnightly Cutting		Three-Weekly Cutting	
		"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil
		per cent.	per cent.	per cent.	per cent.
1	Basic slag ...	25.2	27.8	28.3	28.1
2	Superphosphate of lime ...	25.1	30.3	28.7	29.8
3	Calcium cyanamide ... Basic slag ...	25.6	28.2	28.3	27.3
4	Sulphate of ammonia ... Superphosphate of lime ...	25.4	26.2	30.7	29.8
5	Calcium cyanamide ... Basic slag ... Sulphate of potash ...	28.4	27.5	30.5	25.7
6	Sulphate of ammonia ... Superphosphate of lime ... Sulphate of potash ...	29.1	28.5	30.0	30.0
7	Cattle manure ...	28.3	27.3	29.0	28.9
8	Control ...	26.1	27.4	27.7	28.8
	Maximum ...	29.1	30.3	30.7	30.0
	Minimum ...	25.1	26.2	27.7	25.7
	Average ...	26.7	27.9	29.2	28.6

Table VII

Variations in Calcium Content of Guinea Grass with Different Manurial Treatments.

(Results calculated as calcium oxide (CaO) on a moisture-free basis.)

Serial No.	Details of Manurial Treatment.	Fortnightly Cutting		Three-Weekly Cutting	
		"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil
		per cent.	per cent.	per cent.	per cent.
1	Basic slag ...	0.71	0.93	0.63	0.92
2	Superphosphate of lime ...	0.22	0.68	0.17	0.71
3	Calcium cyanamide ... Basic slag ...	0.71	1.07	0.75	1.05
4	Sulphate of ammonia ... Superphosphate of lime ...	0.42	0.66	0.46	0.64
5	Calcium cyanamide ... Basic slag ... Sulphate of potash ...	0.62	0.99	0.65	0.92
6	Sulphate of ammonia ... Superphosphate of lime ... Sulphate of potash ...	0.41	0.55	0.44	0.53
7	Cattle manure ...	0.36	0.28	0.34	0.26
8	Control ...	0.28	0.28	0.30	0.21

(d) *Calcium.*—Table VII gives the results for the first three-monthly cutting period in respect of the calcium content of the grass in relation to the different manurial treatments and the two intervals of cutting on the two types of soil.

The following conclusions may be drawn:—

(i) Cattle manure in the quantity applied is much less effective than artificial fertilizers.

(ii) Apart from cattle manure on both types of soil and superphosphate of lime on 'heavy' soil, the effect of each manurial treatment is more marked with the 'light' than with the 'heavy' soil.

(iii) The addition of superphosphate of lime to the 'heavy' soil has a depressing effect.

(iv) Calcium applied in the form of a 'basic' manure has a more marked effect than in an 'acid' manure.

(v) The calcium content of the grass does not appear to be affected by an increase in the interval of cutting.

There was no marked tendency for the calcium content to vary with an increase in the age of stools. Table VIII shows the results obtained on both types of soil with the complete 'basic' mixture (No. 5) for a three-weekly interval of cutting over successive three-monthly periods.

It will be noticed that the calcium content does not increase following the application of the manurial dressing.

Table VIII

Variation in Calcium Content of Guinea Grass with Increase in Age of Stools (Manurial Treatment No. 5).

(Results calculated as calcium oxide (CaO) on a moisture-free basis.)

Serial No. of Three-Monthly Cutting Period	Three-Weekly Cutting.	
	"Heavy" Soil	"Light" Soil
	per cent.	per cent.
1 ...	0.65	0.92
2 ...	0.70	1.90
3* ...	0.71	1.09
4 ...	0.60	0.94

* Manure applied during this cutting period.

The only treatment in which there was a definite increase in the calcium content of the grass was that of superphosphate of lime on the 'heavy' soil as the figures in Table IX show. The resultant calcium content of the grass is still, however, very low.

Table IX.

Increase in Calcium Content of Guinea Grass following Application of Superphosphate of Lime.

(Results calculated as calcium oxide (CaO) on a moisture-free basis.)

Serial No. of Three-Monthly Cutting Period	"Heavy" Soil	
	Fortnightly Cutting.	Three-Weekly Cutting.
	per cent.	per cent.
2 ...	0.18	0.16
3* ...	0.21	0.31
4 ...	0.29	0.33

* Manure applied during this cutting period.

Table X.

Variations in Phosphorus Content of Guinea Grass with Different Manurial Treatments.

(Results calculated as phosphoric acid (P_2O_5) on a moisture-free basis)

Serial No.	Details of Manurial Treatment.	Fortnightly Cutting		Three-Weekly Cutting.	
		"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil
		per cent.	per cent.	per cent.	per cent.
1	Basic slag ...	0.52	0.87	0.44	0.75
2	Superphosphate of lime ...	0.27	0.85	0.27	0.82
3	Calcium cyanamide ... Basic slag ...	0.50	0.78	0.47	0.73
4	Sulphate of ammonia ... Superphosphate of lime ..	0.43	0.79	0.42	0.74
5	Calcium cyanamide ... Basic slag ... Sulphate of potash ...	0.49	0.82	0.45	0.72
6	Sulphate of ammonia ... Superphosphate of lime ... Sulphate of potash ...	0.44	0.72	0.43	0.68
7	Cattle manure ...	0.42	0.46	0.38	0.42
8	Control ...	0.31	0.38	0.30	0.31

(e) *Phosphorus*.—The results of analysis for the first three-monthly cutting period in respect of the phosphorus content of the grass in relation to the different manurial treatments and the two intervals of cutting on the two types of soil are shown in Table X.

The following conclusions may be drawn:—

(i) Cattle manure on the 'light' soil in the quantity applied is much less effective than artificial fertilizers.

(ii) Apart from cattle manure and superphosphate of lime on the 'heavy' soil the effect of any particular manurial treatment is more marked with the 'light' than with the 'heavy' soil.

(iii) The depressing effect of the addition of superphosphate of lime to the 'heavy' soil is most noticeable.

(iv) The figures indicate a tendency for the phosphorus content to diminish with an increase in the interval of cutting.

While there was no tendency for the phosphorus content to vary with an increase in the age of the stools the results of analysis indicated a slight increase following the application of a manurial dressing. Table XI shows the results obtained on both types of soil with the complete 'basic' mixture (No. 5) for a three-weekly interval of cutting over successive three-monthly periods.

Table XI.

Variations in Phosphorus Content of Guinea Grass with Increase in Age of Stools (Manural Treatment No. 5).

(Results calculated as phosphoric acid (P_2O_5) on a moisture-free basis)

Serial No. of Three-Monthly Cutting Period.	Three-Weekly Cutting.	
	"Heavy" Soil	"Light" Soil
	per cent.	per cent.
1 ...	0.45	0.72
2 ...	0.48	0.81
3* ...	0.48	0.79
4 ...	0.72	0.90

* Manure applied during this cutting period.

The results of the various determinations may be summarized therefore as follows:—

(i) Manurial treatment has little or no effect on the crude protein content of the grass.

(ii) The crude protein content of the grass tends to decrease with an increase in the age of the stools. The high initial figure is not regained as a result of applications of fertilizers in the quantities used in the experiment.

(iii) As regards increases in both calcium and phosphorus the grass on the 'light' soil responded better to manurial treatment than that on the 'heavy' soil.

(iv) During the initial stages of cutting the depressing effect of superphosphate of lime on the 'heavy' soil in respect of both calcium and phosphorus contents is most noticeable.

(v) 'Basic' manures tend to yield a grass with a higher calcium content than 'acid' manures.

(vi) The phosphorus content shows a tendency to decrease with an increase in interval of cutting and to increase following the application of a manurial dressing.

Table XII, Part I.

"Heavy" Soil.

Average Yields of Guinea Grass at Serdang cut at Four-Weekly, Five-Weekly and Six-Weekly Intervals, November 1935 to July 1936.

(Results calculated in lbs. of grass per acre per day)

Serial No.	Manurial Treatment.	Four-Weekly Interval.	Five-Weekly Interval.	Six-Weekly Interval.	Mean
1	Basic slag ...	62	67	74	68
2	Superphosphate of lime ...	62	60	67	63
3	Calcium cyanamide ... Basic slag ...	65	61	61	62
4	Sulphate of ammonia ... Superphosphate of lime ...	63	66	67	65
5	Calcium cyanamide ... Basic slag ... Sulphate of potash ...	83	77	82	81
6	Sulphate of ammonia ... Superphosphate of lime ... Sulphate of potash ...	80	80	85	82
7	Cattle manure ...	65	79	73	72
8	Control ...	62	57	57	59
	Means ...	68	68	71	
			69		
Significant Difference for Cutting	(9 :1)		5.5		
	(19 :1)		5.9		
Significant Difference for Manurial Treatment —Means	(9 :1)		12.6		
	(19 :1)		15.9		
Significant Difference for Manurial Treatments 'within' Cuttings	(9 :1)		15.4		
	(19 :1)		19.6		

Table XII, Part II.

"Light" Soil.

Average Yields of Guinea Grass at Serdang cut at Four-Weekly, Five-Weekly and Six-Weekly Intervals, November 1935 to July 1936.

(Results calculated in lbs. of grass per acre per day)

Serial No.	Manurial Treatment.	Four-Weekly Interval.	Five-Weekly Interval.	Six-Weekly Interval.	Mean
1	Basic slag ...	50	47	48	48
2	Superphosphate of lime ...	52	48	47	49
3	Calcium cyanamide ... Basic slag ...	52	50	50	51
4	Sulphate of ammonia ... Superphosphate of lime ...	62	60	54	59
5	Calcium cyanamide ... Basic slag ... Sulphate of potash ...	69	75	68	71
6	Sulphate of ammonia ... Superphosphate of lime ... Sulphate of potash ...	77	77	81	78
7	Cattle manure ...	59	56	56	57
8	Control ...	44	44	43	44
	Means ...	58	57	56	
			57		
Significant Difference* for Cutting	(9 :1) (19 :1)		2.9 3.4		
Significant Difference for Manurial Treatment —Means	(9 :1) (19 :1)		8.1 10.1		
Significant Difference for Manurial Treatments 'within' Cuttings	(10 :1) (9 :1) (19 :1)		12.2 14.2		

* See Appendix B.

General.

The marked diminution in yield of grass during the third six months pointed to the advisability of resting the plots to enable the grass to become more vigorous.

Cutting was therefore stopped and attention restricted to merely regular weeding.

There was, however, no marked improvement as a result of the resting period of six months. The foliage of the grass was yellowish-green in colour, and a fair proportion of the stools were dying in the centre.

It was decided, therefore, to replant both areas, thereby starting the second phase of the experiment.

Second Phase. Longer Intervals of Cutting.

In November, 1934, the stools of grass from the first phase were lifted and the land was thoroughly cultivated to a depth of 10 inches.

Cattle manure was applied to all plots at the rate of 10 tons per acre and the area replanted towards the end of January, 1935.

Stools were spaced 3ft. x 3ft., square planting, instead of 2 ft. x 2 ft. as in the first phase, since it was thought that the latter planting system might have been too close for optimum development.

Owing to the wider planting and a change in disposition of guard rows, the number of stools in each sub-plot was reduced to 60, making a total of 240 stools with the four replications. Based on the planting distance, this number of stools corresponds to 1/22nd of an acre.

Manures were applied six months after replanting and were as in the second application in the first phase, *vide* Table II, except that Treatment 7 on 'light' soil consisted of 10,000 lbs. instead of 12,500 lbs. of cattle manure.

Commencing in March, 1935, approximately two months after the completion of replanting, the grass was cut at intervals of about 6 weeks as a preliminary to the regular cutting which started in November, 1935.

The intervals of cutting were as follows:—

'a' sub-plots	—	four weeks
'b' sub-plots	—	five weeks
'c' sub-plots	—	six weeks.

A. Yields of Grass.

The figures for the average yields of grass on the two types of soil for the period November, 1935 to July, 1936, cut at the three intervals mentioned above are shown in Table XII, Parts I and II respectively. Part I of the table gives the figures for the grass on the 'heavy' soil, Part II those for the 'light' soil. The figures have been calculated in lbs. of grass per acre per day.

It will be seen that in spite of cultivation, replanting, basal manuring at replanting and longer intervals of cutting, yields of grass are still low and indicate the need of 2/3 to 3/4 acre per cow.

The least promising feature of the results is the relatively poor showing of Treatment No. 7, where in all nearly 15 tons of cattle manure were applied. The superiority of the complete mixtures is again evident and this is especially marked on the 'light' soil area.

There are no differences remotely approaching significance between yields at different intervals of cutting.

B. Quality of Grass.

Similarly to the first phase, the quality of the grass will be considered in relation to each constituent, comparisons between the results obtained in both phases being also included.

(a) *Moisture.*—The results confirmed those obtained in the first phase in respect of a variation in moisture content with prevailing weather and age of stools. Thus, in the case of the grass on the 'heavy' soil cut at four-weekly intervals, when cutting started in November, 1935, the average moisture content was about 78.5 per cent. During the short dry season (February-March, 1936) the figure fell to about 77 per cent., increasing during the next short wet season (April, 1936) to about 77.5 per cent. This is about 1 per cent. less than the original figure.

Contrary to the first phase, the results showed a slight tendency for the moisture content to decrease with increasing interval of cutting. This applies to both types of soil as the figures given in Table XIII, covering the first six months of the second phase, show:—

Table XIII.

Decrease in Moisture Content of Guinea Grass with Increasing Interval of Cutting.

Type of Soil.	Four-Weekly Cutting	Five-Weekly Cutting	Six-Weekly Cutting.
	per cent.	per cent.	per cent.
"Heavy" Soil...	77.6	76.3	76.0
"Light" Soil ...	76.0	74.8	74.5

(b) *Crude Protein.*—The results may be summarized as follows:—

(i) As in the first phase, manurial treatment has little effect, if any, on the crude protein content of the grass on either type of soil. Table XIV shows the range of variation obtained with one series of samples for one three-monthly cutting period, including the three-intervals of cutting on the two types of soil.

(ii) Contrary to the first phase, the figures in Table XIV show for the same interval of cutting a slightly higher range for the 'light' soil than for the 'heavy' soil.

(iii) The tendency for the crude protein content to decrease with increase in interval of cutting is confirmed.

(iv) Compared with the first phase, the figures in Table XV show only a very slight tendency for the crude protein content to decrease with an increase in the age of the stools. Doubtless this reduced tendency can be correlated with a comparatively low initial figure for the crude protein.

Table XIV.

Variations in Crude Protein Content of Guinea Grass with Different Manurial Treatments.

(Moisture-free basis)

Serial No.	Details of Manurial Treatment.	Four-Weekly Cutting.		Five-Weekly Cutting.		Six-Weekly Cutting.	
		"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil
		per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
1	Basic slag ...	12.3	11.6	10.2	10.6	10.4	11.1
2	Superphosphate of lime ...	10.8	11.8	10.0	10.5	8.9	9.7
3	Calcium cyanamide ... Basic slag ...	12.3	11.8	10.4	11.4	10.7	12.0
4	Sulphate of ammonia ... Superphosphate of lime ...	11.3	12.0	10.8	10.7	10.1	10.4
5	Calcium cyanamide ... Basic slag ... Sulphate of potash ...	11.8	11.7	9.8	10.9	9.9	10.6
6	Sulphate of ammonia ... Superphosphate of lime ... Sulphate of potash ...	10.9	12.2	9.3	11.0	9.4	10.1
7	Cattle manure ...	11.6	12.4	10.8	10.7	10.0	10.1
8	Control ...	12.3	11.9	10.9	11.1	9.8	10.3
	Maximum ...	12.3	12.4	10.9	11.4	10.7	12.0
	Minimum ...	10.8	11.6	9.3	10.5	8.9	9.7
	Average ...	11.7	11.9	10.4	10.9	9.9	10.5

Table XV.

Decrease in Crude Protein Content with Increase in Age of Stools.

(Moisture-free basis)

Serial No. of Three- Monthly Cutting Period.	Four-Weekly Cutting.		Five-Weekly Cutting.		Six-Weekly Cutting.	
	"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
1 ...	11.7	11.9	10.4	10.9	9.9	10.5
2 ...	12.1	12.3	10.5	11.4	9.5	10.4
3 ...	10.2	11.6	9.1	10.0	9.3	9.7

Table XVI.

Varations in Crude Fibre Content of Guinea Grass with Different Manurial Treatments.

(Moisture-free basis)

Serial No.	Details of Manurial Treatment.	Four-Weekly Cutting.		Five-Weekly Cutting.		Six-Weekly Cutting.	
		"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil
		per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
1	Basic slag ...	30.1	30.8	29.5	31.4	31.4	29.9
2	Superphosphate of lime ...	31.2	30.5	31.8	29.9	30.2	32.8
3	Calcium cyanamide ... Basic slag	29.4	31.2	28.4	32.5	31.8	30.8
4	Sulphate of ammonia ... Superphosphate of lime ...	30.4	30.8	32.6	29.7	30.2	32.3
5	Calcium cyanamide ... Basic slag ... Sulphate of potash ...	30.0	30.4	28.9	32.5	31.7	31.4
6	Sulphate of ammonia ... Superphosphate of lime ... Sulphate of potash	30.8	31.8	32.0	30.4	30.6	31.1
7	Cattle manure ...	30.3	31.2	29.6	32.4	30.7	31.4
8	Control ...	31.2	31.0	31.6	29.0	32.1	32.4
	Maximum ...	31.2	31.8	32.6	32.5	32.1	32.8
	Minimum ...	29.4	30.4	28.4	29.0	30.2	29.9
	Average ...	30.4	31.0	30.6	31.0	31.1	31.5

(c) *Crude Fibre.*—The results of analysis confirm those obtained in the first phase in respect of the absence of any correlation between manurial treatment, type of soil and crude fibre content.

The tendency for the crude fibre content to increase slightly with an increase in the interval of cutting is again noticeable.

Figures for one series of samples for one three-monthly cutting period, including both types of soil and the three intervals of cutting, are given in Table XVI.

As far as could be ascertained, there was no tendency for the crude fibre content to vary with an increase in the age of the stools.

As regards the gradual increase of crude fibre content with increase in interval of cutting, the results in Table XVII, in which the average figures obtained in both phases are given, are of interest.

Table XVII.

Increase in Crude Fibre Content of Guinea Grass with Increasing Interval of Cutting.

(Moisture-free basis)

Interval of Cutting.	"Heavy" Soil	"Light" Soil
weeks	per cent.	per cent.
2 ...	26.7	27.9
3 ...	29.2	28.6
4 ...	30.4	31.0
5 ...	30.6	31.0
6 ...	31.1	31.5

(d) *Calcium.*—Table XVIII gives the results for the first three-monthly cutting period in respect of the calcium content of the grass in relation to the different manurial treatments and the three intervals of cutting on the two types of soil.

Although the figures in a few instances are somewhat irregular, many of the results confirm the findings in the first phase, *e.g.*

(i) Cattle manure in the quantity applied is less effective than artificial fertilizers.

Table XVIII.

Variations in Calcium Content of Guinea Grass with Different Manurial Treatments.

(Results calculated as calcium oxide (CaO) on a moisture-free basis)

Serial No.	Details of Manurial Treatment.	Four-Weekly Cutting.		Five-Weekly Cutting.		Three-Weekly Cutting.	
		"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil
		per cent.	per cent.	per cent.	per cent.	per cent.	per cent
1	Basic slag ...	0.69	0.83	0.63	0.91	0.94	0.90
2	Superphosphate of lime ...	0.37	0.72	0.41	0.70	0.55	0.79
3	Calcium cyanamide ... Basic slag ...	0.91	0.92	0.89	0.75	0.84	0.92
4	Sulphate of ammonia ... Superphosphate of lime ...	0.46	0.78	0.69	0.70	0.76	0.71
5	Calcium cyanamide ... Basic slag ... Sulphate of potash ..	0.76	0.74	0.76	0.86	0.82	1.02
6	Sulphate of ammonia .. Superphosphate of lime .. Sulphate of potash ..	0.57	0.47	0.57	0.55	0.71	0.59
7	Cattle manure ...	0.48	0.59	0.43	0.46	0.45	0.55
8	Control ...	0.48	0.44	0.38	0.45	0.49	0.52

(ii) Apart from cattle manure on both types of soil and superphosphate of lime on 'heavy' soil, the effect of any particular manurial treatment appears to be more marked with the 'light' than with the 'heavy' soil.

(iii) The depressing effect of superphosphate of lime on the 'heavy' soil is again noticeable. The effect becomes less marked apparently with an increase in the interval of cutting.

(e) *Phosphorus.*—Table XIX gives the figures for the first three-monthly cutting period for the phosphorus content of the grass in relation to the different manurial treatments, the three intervals of cutting and the two types of soil.

The results differ considerably from those obtained in the first experiment.

Apart from cattle manure, which in the quantity applied is less effective than artificial fertilizers, all manurial treatments, 'basic' and 'acidic,' yield grass having on the average a remarkably high phosphorus content.

Unlike the results in the first phase, there is no definite indication of a decrease in phosphorus content with an increase in interval of cutting.

Apart therefore from phosphorus, the results may be said to confirm those obtained in the first phase.

Summary of Experiments on Quality of Grass.

Comparing the results obtained in the two phases the combined figures for moisture, crude protein and crude fibre indicate a four-weekly interval of cutting as the limit of the interval to ensure a grass that will be both palatable and not unduly deficient in crude protein. A crude protein content of 11.5 per cent., calculated on a moisture-free basis, corresponds to approximately 2.6 per cent. on the fresh basis (77 per cent. moisture). This figure is only slightly less than that of 3 per cent. published in literature for average meadow grass in Europe.

As regards the mineral content of the grass the figures show that with certain manurial dressings, particularly 'basic' manures, both the calcium and the phosphorus contents of the grass can be more than doubled.

Table XIX.

Variation in Phosphorus Content of Guinea Grass with Different Manurial Treatments.

(Results calculated as phosphoric acid (P_2O_5) on a moisture-free basis)

Serial No.	Details of Manurial Treatment.	Four-Weekly Cutting.		Five-Weekly Cutting.		Six-Weekly Cutting.	
		"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil	"Heavy" Soil	"Light" Soil
		per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
1	Basic slag ...	0.88	0.98	0.92	0.97	0.77	1.03
2	Superphosphate of lime ...	0.89	0.92	0.68	1.00	0.65	0.98
3	Calcium cyanamide ... Basic slag ...	0.81	1.09	0.93	0.87	0.90	0.86
4	Sulphate of ammonia ... Superphosphate of lime ...	0.93	0.83	0.81	1.01	0.79	1.14
5	Calcium cyanamide ... Basic slag ... Sulphate of potash ...	0.67	0.88	0.81	0.90	0.86	0.88
6	Sulphate of ammonia ... Superphosphate of lime .. Sulphate of potash ...	0.98	1.04	0.82	0.77	0.84	0.90
7	Cattle manure ...	0.60	0.74	0.62	0.54	0.50	0.48
8	Control ...	0.57	0.77	0.41	0.92	0.46	0.75

Second Experiment.

Towards the end of 1934 a second experiment was laid down primarily to test different planting distances, but also to ascertain whether better yields than those recorded in the first experiment could be obtained from low-lying land and whether the comparative ineffectiveness of cattle manure would be maintained on such land.

A flat well-drained area on a loam soil at the foot of a slope was chosen (see soil analysis in Table I). The area had previously been a swamp which, after drainage, was planted with carpet grass as a grazing paddock. In 1932, it was ploughed and limed at the rate of 1 ton per acre and kept under *Crotalaria usaramoensis* until October, 1934, when it was dug over and cleaned.

The lay-out was in the form of a four-way Latin Square with plots of 1/10th acre planted "A" 4ft. x 2ft., "B" 3ft. x 2ft., "C" 2ft. x 2ft., "D" 3ft. x 3ft., giving 5,445, 7,250, 10,890 and 4,840 plants per acre. Columns were split into alternate strips receiving cattle manure at the rate of 10 tons per acre per annum and basic slag at the rate of 750 lbs. per acre per annum. Grass was planted in November, 1934; cutting at a uniform monthly rate commenced January, 1935.

Yields, expressed in lbs. of grass per acre per day, are given in Table XX for the period January, 1935 to June, 1936. It will be observed that there were no differences in yield between grass at different planting distances.

Table XX.

Yield of Guinea Grass in lbs. per Acre per Day.

Block 41. First Phase.

	January-December, 1935.					January-July, 1936.				
	A	B	C	D	Mean	A	B	C	D	Mean
Cattle manure ...	175	177	180	175	177	79	79	81	80	80
Basic slag ...	172	176	179	168	173	65	66	65	65	65
Mean ...	174	177	180	171	*176*	72	73	73	73	*73*

Examination of monthly yields (given in Table XXI) shows that differential response to the two manures was manifested only after the fifteenth month.

Table XXI.

Monthly Yields expressed as lbs. of Grass per Acre per Day.

Date	Cattle Manure	Basic Slag.
1935		
January ...	356	400
February ...	195	218
March ...	342	330
April ...	208	206
May ...	198	220
June ...	130	127
July ...	128	125
August ...	134	135
September ...	134	132
October ...	112	99
November ...	92	89
December ...	82	81
1936		
January ...	84	84
February ...	86	84
March ...	57	55
April ...	87	56
May ...	85	62
June ...	83	56

Second Phase.

It was decided to increase the quantity of cattle manure to 15 tons per acre per annum, and to test the effect of nitrogen and potash. To effect this, all basic slag plots received nitrogenous fertilizers, and half of them potash in addition, while half the cattle manured plots received potash at the rates shown in Table XXII.

Table XXII.

Manurial Applications in Second Phase.

Manure	Rate per acre per annum.	Time of Application.	Equivalent to lbs. per annum of—
F.M. Cattle manure	15 tons	January, July	lbs. 270 nitrogen (N)
			400 phosphoric acid (P_2O_5)
			107 potash (K_2O)
F.M.+K. Cattle manure	15 tons	January, July	270 N
Sulphate of potash	1 cwt.	„ „	400 P_2O_5
			164 K_2O
N.P. Calcium cyanamide	2 cwts.	January, July	88 N
Sulphate of ammonia	2 „	April, October	
Basic slag	4 „	January, July	71 P_2O_5
NP+K. As N.P. and sulphate of potash	1 cwt.	January, July	88 N
			71 P_2O_5
			57 K_2O

It will be noted that equivalence between the artificial fertilizer and cattle manure has been abandoned; this is essential if costs of the former are not to become fantastic. Both forms of nitrogenous artificials were employed on the off-chance that if one were not nitrified the other might be.

Sub-plots remained at 1/20th acre and there were accordingly only two replicates of each manurial treatment for each planting distance. It was, however, anticipated that there would be no appreciable interaction between planting distance and manures.

Table XXIII gives the results of these heavier dressings and shows that artificial fertilizers have merely maintained yields at a low level, while enhanced application of cattle manure has raised yields to a figure of approximately 100 lbs. per acre per day (equivalent to 16 tons per acre per annum)—a quantity sufficient to support slightly more than 2 cows per acre. These 2 cows would in turn produce 80 lbs. of manure per day or 13 tons per annum, rather less than the quantity supplied.

Table XXIII.

Yields of Guinea Grass in lbs. per Acre per Day - Block 41 - Second Phase.

	July-December, 1936.					January-June, 1937					July-December, 1937.				
	A	B	C	D	Mean	A	B	C	D	Mean	A	B	C	D	Mean
F.M. ...	91	91	86	87	89	104	114	112	99	107	111	118	113	89	108
F.M.K. ...	85	87	93	89	89	106	102	99	108	103	106	99	112	105	106
N.P. ...	50	46	53	49	50	55	50	53	52	53	63	61	58	60	61
N.P.K. ...	53	51	56	51	53	55	53	55	59	56	61	64	70	62	64
Mean ...	70	69	72	69	70	80	80	80	80	80	85	86	88	79	85

Composition of Grass.

Samples of grass were taken in February and March, 1938, and the results of analyses are given in Table XXIV. It will be noted that grass from the poor "artificial" plots is actually better in composition (as measured by protein and fibre content) than that from plots receiving cattle manure. This result confirms those from the first experiment and is important in proving that poor yields do not connote poor material.

Summary.

Experiments designed to ascertain response of Guinea grass to different manurial treatments, intervals of cutting and planting distances are discussed. It is shown that phosphatic manures might be useful to start a new area, but that cattle manure at the rate of 10 to 15 tons per acre per annum is essential if even moderate yields are to be maintained.

Average yields on plots manured with cattle manure at the rate of 10 tons or more per acre per annum were:—on sloping land of medium texture 70 to 80 lbs. of grass per day; on flat light land of poor fertility 55 lbs. per day, and on flat land of medium texture 100 lbs. per day. Taking a daily ration of 40 lbs. of grass per animal 1 acre of grass in these situations would support approximately 1.8, 1.3 and 2.5 cows respectively. If production of manure (including bedding) is taken as 40 lbs. per day (6.5 tons per annum), the maximum manure available for application is 11.7, 8.5 and 16.3 tons per annum. The ration of 40 lbs. grass per day is for local (Indian) cattle; if pure-bred Friesians were stocked a considerably higher ration would be necessary.

Table XXIV.

Results of Analysis of Samples of Guinea Grass from Second Experiment at Serdang.

Manurial Treatment	Moisture Content per cent.	Crude Protein	Crude Fibre	Calcium as CaO	Phosphorus as P_2O_5	Potassium as K_2O
F. M.	75.8	11.8	30.4	1.15	0.68	1.17
F. M. K.	76.3	10.9	31.2	0.72	0.57	1.94
N. P.	75.8	18.3	26.1	1.68	0.60	0.79
N. P. K.	75.8	14.9	28.4	1.34	0.75	0.95

Intervals of cutting ranged from 1 to 6 weeks; the former was found to be much too drastic and yields from fortnightly cuttings on one soil type were significantly (though not markedly from an economic view point) lower than longer intervals. There were no economic differences in yield from 3, 4, 5 and 6 weekly cuttings. Variation in planting distances ranging from 2ft. x 2ft. to 4ft. x 2ft. gave no great differences in yield but an indication that 4ft. x 2ft. was too wide.

Fodder value of the grass measured by crude protein and fibre content was satisfactory when the cutting intervals did not exceed 4 weeks and there was no serious falling off of value with falling yield. There were rather puzzling variations in mineral content of grass, but these are of minor importance in that minerals can be added far more easily and cheaply to rations than increased in grass by application of artificial fertilizers.

Conclusions.

Yields far below figures commonly suggested for Guinea grass, *viz.* 30 to 40 tons per acre per annum, have been recorded at the Central Experiment Station, Serdang, and it seems unsafe on soils of the type normally encountered in Malaya to estimate for stocking at a rate exceeding $1\frac{1}{2}$ cows per acre on soil of moderate fertility and 2 cows per acre on better soil. All the manure would have to be returned to the land and none would be available for use in market gardening.

Even the lowest rate shows a great advantage for stall feeding over pasturage where at least 3 acres would be required to support a cow.

In Leaflet No. 8 of this Department, "Fodder Grasses," it is stated that replanting should be undertaken "when the stools show signs of deterioration and production diminishes, *i.e.* during the third or fourth year." The experiments described suggest that diminution of yield should be taken to refer to yield after the fourth month. Diminution from high values in the first few months may be expected as a normal occurrence. In the first experiment, with inadequate quantities of manure, replanting was necessary after two years; in the second with heavier manuring the stools on cattle manured plots are still healthy three years from planting. It is fair to assume therefore that on soil of reasonable fertility and with adequate manuring the period indicated in the leaflet should be attained without difficulty.

Future Work.

Heavier dressings of cattle manure, and the effect of inter-row cultivation, which was absent from both experiments, will be tried on all three soil types and a comparison of yields of elephant grass with Guinea grass will be made on the soils of the first experiment.

APPENDIX 'A.'

Sampling and Analysis of Guinea Grass at Serdang.

The following is a short description of the sampling and analytical methods adopted in the investigation.

Sampling Procedure.

Commencing from one of the four corners of the sub-plot and looking lengthwise along the sub-plot, any stool of grass in the first six of the outside row is selected, the grass being cut and set aside.

The next stool for cutting is found by moving along to the next row and taking the sixth stool farther along the row, counting from the stool adjacent to that which has already been cut.

A similar procedure is followed until eventually the last stool is taken from the corner diagonally opposite to that in which cutting was commenced.

An example will make the method clear. Assuming that stool No. 3 in the outside row has been selected as the starting point of the cutting, the succeeding stools will be No. 9 in the second row, No. 15 in the third row and so forth.

A similar procedure is followed with the other three sub-plots, the whole of the grass from the four replicates being mixed and constituting a sample from one manurial treatment for a definite interval of cutting.

Since there were eight manurial treatments on two different types of soil the number of samples on each occasion of cutting amounted to sixteen.

The samples were despatched without delay to the laboratory for analysis.

Analytical Procedure.

The analysis of the grass comprised determinations of (a) moisture, (b) crude protein, (c) crude fibre, (d) calcium and (e) phosphorus.

In view of the low crude fat content (ether extract) of the fresh grass, 0.2 per cent. or less, and its relative unimportance as regards composition, it was considered unnecessary to carry out routine analyses in respect of this constituent.

Owing to the large number of samples during the first phase of the first experiment and the impossibility of carrying out individual analyses, analytical work, apart from moisture determinations, was restricted to the estimation of the particular constituents in average samples of grass for the same manurial treatment and interval of cutting collected during a definite period.

The following procedure was therefore adopted. Each sample of grass on arrival was quartered until approximately 200 grammes remained. This quantity was finely chopped, after which two samples for analysis were drawn. Moisture was determined in one sample, crude protein in the other. The sample in which moisture was determined was used subsequently for the determination of the other constituents.

(a) *Moisture.*—Fifty grammes were dried for 24 hours in an electric oven heated to a temperature of 65° to 70°C. The material was allowed to cool and the loss in weight recorded.

A relatively low temperature for desiccation was chosen to reduce to a minimum the possibility of decomposition; the period of drying was maintained at 24 hours to ensure the moisture content of the grass being reduced sufficiently to enable the dried material to be stored without becoming mouldy.

Experiments showed that when dried under these conditions the grass still retained between 5 and 6 per cent. of moisture. A figure of 6 per cent. was accordingly allowed when calculating the absolute moisture content of the fresh grass from the loss in weight recorded by drying for 24 hours at 70°C.

As explained previously, the oven-dried samples were retained until the expiration of the cutting period for the other constituents, being mixed with corresponding samples covering the same manurial treatment and interval of cutting.

It was found that during storage the moisture content of the oven-dried grass increased gradually to about 13 per cent., after which it remained approximately constant. When weighing samples for analysis, therefore, an allowance was made on the above basis; for example, in those cases in which 5 grammes of the moisture-free grass were required 5.75 grammes of the air-dry grass were weighed.

(b) *Crude Protein.*—Five grammes of the fresh grass are digested with 25 cc. of concentrated sulphuric acid, also small amounts of potassium sulphate and copper sulphate, until a clear liquid remains. The latter is diluted with water and the solution adjusted to 250 cc. An aliquot portion, 50 cc., is withdrawn and placed in a bottle, to which are added similar aliquot portions from the corresponding samples of grass for the same manurial treatment and interval of cutting for the remainder of the cutting period.

When the cutting period has been determined, an aliquot portion of the bulked acid solution, corresponding to 2 grammes of the fresh grass, is made alkaline with caustic soda and the ammonia distilled into standard acid, the excess of which is determined by titration with standard alkali. The percentage of crude protein is obtained by multiplying the percentage of nitrogen by the factor 6.25.

(c) *Crude Fibre.*—A quantity of 1.15 grammes of the air-dry grass (1 gramme of moisture-free grass) is boiled for half-an-hour with 75 cc. of 70 per cent. acetic acid, 5 cc. of concentrated nitric acid and 2 grammes of trichloracetic acid under a reflux condenser. The liquid is diluted with water and the contents of the flask filtered through muslin. The residue on the muslin is washed with hot water until free from acid, then with small amounts of alcohol and ether, and dried to constant weight in the steam-oven. The residue is ignited and weighed, the loss in weight being calculated as crude fibre.

(d) *Calcium.*—A quantity of 5.75 grammes of the air-dry grass (5 grammes of the moisture-free grass) is ignited in an electric muffle furnace at a temperature not exceeding 500°C. until a slightly pale grey ash is left. The ash is treated with hydrochloric acid and, after removal of traces of carbon and silica, the solution is made up to 100 cc., aliquot portions being taken for the determination of calcium and of phosphorus.

Calcium is precipitated as calcium oxalate from the acid solution by the appropriate method. Care must be taken to add sufficient ferric chloride to the solution to prevent any of the calcium being precipitated as phosphate when the acid solution is neutralized with ammonia.

The calcium oxalate is filtered off, treated with dilute sulphuric acid and the oxalic acid titrated with standard potassium permanganate. The appropriate factor for converting oxalic acid to calcium oxide is used, in which form the calcium is calculated.

(e) *Phosphorus.*—Phosphorus is precipitated as ammonium phospho-molybdate from the acid solution by the appropriate method. The yellow ammonium phospho-molybdate precipitate is filtered off, treated with an excess of standard potassium hydroxide in which it dissolves, and the excess of standard alkali titrated with standard acid. An appropriate factor for converting standard alkali to phosphoric acid is used, in which form the phosphorus is calculated.

During the second phase of the first experiment, that is longer intervals of cutting, it was possible to dispense with bulking of oven-dried grass and acid solutions owing to the smaller number of samples, the individual samples as received from Serdang being analysed direct.

A change was also made in the catalyst used when digesting fresh grass with concentrated sulphuric acid in the determination of crude protein. Selenium was substituted for copper sulphate.

APPENDIX 'B.'

Statistical Analysis of the Experiments.

First Experiment.

Strictly speaking, statistical analysis can be applied only to the results of the first experiment on the means of manurial treatments, since randomization was limited to plots, sub-plots with different intervals of cutting being arranged in regular sequence. This was recognized at the outset, but the difficulty of supervision of a completely randomized experiment could not have been effectively overcome in the early stages of the experiment.

An attempt has been made to overcome this statistical disadvantage by subtracting two degrees of freedom from the available total of 95, representing the imposed position (horizontal and vertical) of sub-plots in blocks.

Actual analysis was confined to the periods (a) December, 1932 to March, 1933 (part of first phase) and (b) November, 1935 to July, 1936 (second phase). The coefficients of variability found agree remarkably well as follows:—

	"Heavy" Soil		"Light" Soil	
	(a)	(b)	(a)	(b)
Cuttings	14.2	14.1	14.2	12.6
Manures	14.8	12.2	11.9	10.3
Individual treatment *i.e.* Manure x Cultivation.	16.4	16.2	15.7	14.4

Since there has been so little change of variance between the start and finish of the experiment, it is reasonably safe to assume that similar figures will apply to intermediate stages and the following assumed round figures have been used in calculating "significant differences" in Table III.

	"Heavy" Soil.	"Light" Soil.
Cuttings	14	13
Manures	13	10
Individual treatment	16	15

Second Experiment.

Yields from the second experiment have not been statistically analysed. Inspection of the records shows that variation is of the same order as that of the first experiment and that the only difference which could attack significance is that between cattle manure and artificial fertilizers.

Reference.

1. Greenstreet V. R. and Greig J. L. Manurial Experiments with Guinea Grass at Serdang. *Malayan Agricultural Journal,* Vol. XXI, No. 11, November 1933, p. 543.

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CAROTENE IN PALM OIL

BY
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The special dietetic value of palm oil, arising from its pigment carotene, which is a precursor of Vitamin A, is becoming increasingly recognized. There are local publications on the subject ([1], [2] & [3]) and in one of them ([2]) an account is given of the isolation of carotene from palm oil. Several methods of isolating carotene were tried and the most successful was tedious and prohibitive in cost.

The pigment of palm oil, however, is a nuisance in many fields of industry, and is either destroyed or removed from the oil. It is commercially removed by adsorption on activated fullers' earth when the product is required for making high grade toilet soap or even for white edible fats. Experiments have been made in this Department from time to time on adsorptive bleaching of palm oil, but without satisfactory results until recently. Earths activated for use and also proprietary products vary widely in activity, and now two samples of activated earth obtained from the Fullers' Earth Union Ltd., Redhill, Surrey, have given favourable results.

It has also been found that the earth filtered off from the bleached oil can be washed almost free from adhering oil by means of petroleum ether, without any of the adsorbed carotene being extracted. Afterwards, when the washed earth is suspended in acetone the carotene instantly passes into solution, and after evaporation of the filtered solution under reduced pressure, a small bulk of oleaginous residue contains the carotene. If ether is used, after washing the earth, the carotene appears to pass into solution, but after the earth has been exhausted by ether, acetone removes a further amount. Ethyl acetate behaves similarly to ether. The differentiation observed may be due to the different forms of carotene occurring in palm oil.

No attempt has been made to purify the crude acetone extract, but it appears that the above procedure offers a very convenient way of obtaining carotene. Even with incomplete washing of adhering oil from the used earth, the product would be a "concentrate" very rich in carotene.

It may be added that as the bleaching may be carried out in a vacuum and at a temperature below 100°C., it should be easy to avoid the possibility of oxidation.

1. Rosedale, *Malayan Medical Journal,* Vol. IX p. 140, 1934.
2. Simpson. Bulletin of the Institute for Medical Research, No. 1 of 1936.
3. Buckley, *Malayan Agricultural Journal,* Vol. XXIV p. 485, 1936.

Received for publication 24th May, 1938.

Departmental.

FROM THE DISTRICTS.

Compiled by the Chief Field Officer from Monthly Reports of Agricultural Officers.

May, 1938.

The Weather.

In Kedah the rainfall, though less than in April, was abundant and in excess of the normal precipitation for this month. The second half of the month was also very wet in Penang.

In Kelantan the dry weather experienced during the previous month came to an end and the rainfall was regular and a little above average. The East Coast of Pahang, was, however, abnormally dry.

Throughout the west coastal areas the precipitation was very much lower than during April. The dry weather period has now set in. In Perak and Selangor the weather was hot with some showers. In the inland districts of Pahang and Negri Sembilan light and regular rain was experienced and the total precipitation was about average. In Malacca the latter half of the month was rather dry.

Rainfall in Johore was on the whole normal for this time of the year, but the distribution was very uneven and at Segamat and Batu Pahat conditions of drought prevailed. In the South East and at Singapore there was rather more rain and the total precipitation was above average.

Remarks on Crops.

Rubber.—The market price of rubber was, if anything, slightly lower than during the previous month; $22 to $23 were the highest prices paid by dealers for smoked sheet.

In a great many parts there has been a definite decline in the value of export rights, a common quotation being $13 per picul equivalent. On the other hand, the price of coupons in Malacca rose to $18 per picul equivalent, whereas the price of uncouponed rubber fell to as low as $4 per picul.

Although the difference in the price between smoked and unsmoked sheet is, in many instances, very small, the erection of many additional smoke cabinets is recorded in reports, notably in Perak where the number was increased by 3 and in Pahang where 9 were erected.

The scheme whereby rubber dealers display samples of grades and a list of prices outside their shops, which was inaugurated in Pahang, is being brought into force in Perak and Selangor.

Padi.—The price of padi in Penang has increased to $2.20 per picul. At the Government Rice Mill in Krian $2.10 per picul is still being paid. In Krian approximately 92,000 bags of the strain "S.48" have been inspected and sealed as a guarantee of qualification for the premium of 10 cents a picul paid at the Government Mills for this strain.

The harvest in Krian and the north of Perak has now been completed and the land is lying fallow. In the south, in the Dindings and at Panchang Bedina and Tanjong Karang some of the crop still remains to be harvested.

In central Johore it is reported that economic stress has resulted in greater interest in padi planting and areas which have long been out of cultivation are being reopened. As irrigation facilities are not available on the lands concerned, the prospect of cultivators obtaining any great quantity of padi as a result of their efforts is small.

Pineapples.—The price of canned pineapples still remains very low. Most of the fruit at present being canned is grown in large plantations. The price paid for fresh fruit (at present 40 to 60 cents per hundred in Selangor, 80 cents to $1.30 in Singapore) does not make it worth while for the small-holder to sell his small quantities of fruit to the factories.

FERTILIZER PRICES, MAY, 1938.

The following are the prices at the end of May, 1938, of some of the more important fertilizers.

Product.	Analysis				Price per ton $
	Nitrogen (N)	Phosphoric Acid (P_2O_5)		Potash (K_2O)	
		Soluble	Insoluble		
Sulphate of Ammonia ...	20.6	—	—	—	72.75
Calcium Cyanamide ...	20.6	—	—	—	80.00
Muriate of Potash ...	—	—	—	50	112.00
Sulphate of Potash ...	—	—	—	48	112.00
Superphosphate (concentrated) ...	—	39 - 40	—	—	105.00
Superphosphate ...	—	16 - 18	—	—	60.00
Basic Slag ...	—	16	—	—	48.00
Rock Phosphate (Christmas Island) ...	—	11*	38‡	—	33.50
Rock Phosphate (very finely ground Gafsa) ...	—	11*	26 - 28‡	—	40.00
Lime ...	—	—	—	—	20.00

* Citric soluble. ‡ Total.

Quotations are ex Warhouse, Port Swettenham, Klang, Singapore and Penang, with the exception of muriate of potash which is *ex* warehouse, Port Swettenham, Klang and Singapore.

The above quotations for concentrated superphosphate, superphosphate and Christmas Island phosphate are *ex* warehouse Penang, Port Swettenham and Klang. The Singapore quotations for these three fertilizers are $95, $50 and $31.50 per ton respectively.

Statistical.

MARKET PRICES.

May 1938.

Major Crops.

Rubber.—Prices were on a low level throughout the month with only minor fluctuations. Spot loose opened in Singapore at 18¼ cents per lb. and rose to 20⅛ cents on the 12th May; it subsequently weakened again, falling to 17¾ cents on the 27th, but recovered to close at 18⅞ cents.

The average price for the month of No. 1, X. Rubber Smoked Sheet was 18.96 cents per lb., as compared with 19.26 cents in April. The London average price was 5.63 pence per lb., and the New York price 11.49 cents gold, as compared with 5.77 pence and 11.69 cents gold in the previous month.

Prices paid for small-holders' rubber at three centres during the month are shewn in Table I.

Table I.

Weekly Prices Paid By Local Dealers for Small-Holders' Rubber, May, 1938.

(Dollars per Picul.)

Grades.	Kuala Pilah, Negri Sembilan.			Kuala Kangsar, Perak.		Batu Pahat, Johore.			
	5	12	26	11	18	4	11	18	25
Smoked sheet		24.00	22.20	23.00	22.50				20.00
Unsmoked sheet	21.00	21.50	20.50		20.00	20.00	20.90	19.80	18.50
Scrap									

Transport by F.M.S.R. lorry service Kuala Pilah to Seremban 12 cents per picul, to Malacca excluding duty, 25 cents per picul, by rail Seremban to Penang $1.24 per picul, Seremban to Singapore $8.00 per ton.

Transport from Batu Pahat to Singapore by lorry excluding duty, 90 cents per picul.

Transport from Kuala Kangsar to Prai by railway $6.20 per ton.

Transport from Kuala Kangsar to Singapore by railway $10.00 per ton (minimum consignment 5 tons).

At Kuala Pilah the standard deduction for moisture in unsmoked sheet is 5 per cent.

At Kuala Kangsar the standard deduction for moisture in unsmoked sheet is 10 per cent.

No purchases at Kuala Kangsar on the 4th and 25th May, and at Kuala Pilah on the 19th May.

Palm Oil.—The Market for palm oil maintained its position, but lower prices were recorded for palm kernels. Quotations during May are given in Table II.

Table II.

Prices of Palm Oil and Palm Kernels.

Date 1938.	Palm Oil in Bulk, c.i.f. landed weight Liverpool/ Halifax.	Palm Kernels, c.i.f. landed weight London/ Continent
	per ton	per ton
May 6	£ 14. 0. 0	£ 9. 10. 0
„ 13	14. 0. 0	9. 7. 6
„ 20	14. 10. 0	9. 7. 6
„ 27	14. 0. 0	8. 17. 6

Copra.—For the first half of May the market remained steady, but weakened considerably towards the end of the month. The sun-dried grade opened at $3.80 per picul and maintained this level until the 19th May, after which date it fell steadily to close at $3.25, with an average for the month of $3.71 per picul, the mixed grade continuing 40 cents lower. The April average price was $3.62 per picul.

Copra cake rose to $2.10 per picul at the end of the month. The average price was $1.88 per picul.

Rice.—The average wholesale Singapore prices of rice per picul in April were as follows:—Siam No. 2 (ordinary) $3.98; Rangoon No. 1 $3.62; Saigon No. 1 $3.85; as compared with $4.09, $3.62 and $3.92 in March, and with $4.40, $3.57 and $3.70 in April 1937.

The average retail prices in cents per gantang of No. 2 Siam rice were again unchanged: Singapore 28, Penang 32, Malacca 28.

The average declared trade value of imports during April was $3.91 per picul as compared with $3.89 in March and $3.85 in February.

Padi.—The Government Rice Mills, Perak, continued to pay $2.10 per picul for padi. The price in the field tended to rise, the usual price in padi-growing districts being from $8 to $9 per 100 gantangs, while in towns and non-padi growing districts the price was between $10 and $15 per 100 gantangs.

Pineapples.—Prices per case of canned pineapples remained unchanged over those of last month, and were as follows:—G.A.Q.: Cubes $2.70, Sliced Flat $2.65, Sliced Tall $2.80; Golden Quality: $2.85, $2.80 and $2.95 respectively.

Beverages.

Tea.—Six consignments of Malayan tea were sold on the London Market during May, one upland and five of lowland tea. The upland tea sold at 1s. 3d. per lb., while the prices of the lowland tea ranged from 1s. 0d. to 1s. 1¾d. per lb.

Average London price per lb. during May for consignments of tea from other countries were as follows:—Ceylon 1s. 3. 22d., Java 1s. 1. 82d., Indian Northern 1s. 2. 22d., Indian Southern 1s. 2. 81d., Sumatra 1s. 09d.

The latest Colombo average prices available, quoted from *The Weekly Tea Market Report,* 24th May, 1938, of the Colombo Brokers' Association, are as follows, in rupee cents per lb.: High Grown Teas 75 cents, Medium Grown Teas 67 cents, Low Grown Teas 63 cents.

Coffee.—Palembang coffee improved slightly to average $11.12 to $13.12 per picul, while Sourbaya weakened to $9.19 to $10.19. The April averages were $8.44 to $9.44 and $11.88 to $12.94.

Prices in Singapore of other varieties of coffee were as follows (per picul):—Liberian $14, Excelsa $10, falling to $9; Robusta $7, falling to $6.50.

Spices.

Arecanuts:—The range of Singapore prices per picul during the month was as follows:—Splits $4.06 to $5.94; Red Whole $4.19 to $6.25; Sliced $6.31 to $8.50.

The averages of the Singapore Chamber of Commerce quotations per picul were:—Best $7.17, Medium $6.62, Mixed $6.19.

Pepper.—The price of black pepper was quoted throughout the month at last month's figure, viz. $8.25 per picul. White and Muntok declined 25 cents at the end of the month to $13.50 and $13.75, the average prices during May being White $13.69, Muntok $13.94, as compared with $13.75 and $14 in April.

Nutmegs.—The price of both 110's and 80's dropped $1 per picul to $30 during the second half-month, the average price of both grades being $30.50 per picul as compared with $32 in April.

Mace.—The price of Siouw continued unchanged throughout the month at $90, while Amboina was marked down $1 at $74 per picul.

Cloves.—Zanzibar and Amboina cloves were quoted unchanged at $40 per picul (nominal).

Cardamoms.—Green cardamoms were quoted in the Ceylon Chamber of Commerce reports for May from Rs. 1.30 to Rs. 1.60 per lb.

Miscellaneous.

Derris.—Values of average qualities have a downward tendency owing to fair supplies being available and to lack of orders from abroad. Prices for the better rotenone varieties, however, have been well maintained, as supplies, which are rather small, are promptly taken up by the trade. Average prices in May were, for roots sold on a basis of ether extract $15 to $16 per picul; root sold on rotenone content $24 per picul.

Gambier.—Block gambier improved 50 cents per picul over April quotations at $7.50 per picul; No. 1 Cube remained at $15.50 per picul.

Tapioca.—The price of Flake Fair dropped 15 cents per picul during the second half of the month, while Seed Pearl and Medium Pearl declined 25 cents. Average prices per picul in May were:—Flake Fair $4.17, Seed Pearl $4.12, Medium Pearl $4.87 as compared with $4.25, $4.37, $5.

Sago.—Prices shewed some decline over those ruling in April. Pearl, Small, Fair averaged $3.61; Flour, Sarawak Fair, $1.95, as compared with $3.87 and $2.19 respectively in April.

Tobacco.—The price of tobacco varies considerably from district to district. The general range of prices per picul for dried leaf was as follows:—1st quality $30 to $45; 2nd quality $20 to $35; 3rd quality $10 to $25. Prepared tobacco prices per picul were:—Lower Perak $64 to $100; Kelantan 1st quality $105, 2nd quality $87.50; 3rd quality $62.50; Negri Sembilan $58, $48, $38. Java tobacco in Johore was sold at $40 to $80 per picul.

The above prices are based on London and Singapore daily quotations for rubber; on the Singapore Chamber of Commerce Weekly Reports for the month and on other local sources of information. Palm oil reports and certain coffee prices are kindly supplied by Messrs. Guthrie & Co. Ltd., Kuala Lumpur; the Singapore prices for imported coffee and arecanuts by the Lianqui Trading Company of Singapore, and derris prices by Messrs. Kohyei & Co., and Messrs. Hooglandt & Co., Singapore.

1 picul = 133 1/3 lbs. The Dollar is fixed at two shillings and fourpence.

Note.— The Department of Agriculture will be pleased to assist planters in finding a market for agricultural produce. Similar assistance is also offered by the Malayan Information Agency, 57, Trafalgar Square, London, W.C.2.

GENERAL RICE SUMMARY*

April, 1938.

Malaya.—Imports of foreign rice during April were 67,137 tons,† and exports 15,390 tons, net imports being 51,747 tons as compared with 47,364 tons in 1937.¶

Of the imports during April, 49 per cent. were consigned to Singapore, 16 per cent. to Penang, 6 per cent. to Malacca, 22 per cent. to the Federated Malay States and 7 per cent. to the Unfederated Malay States. The foreign imports by countries of origin were as follows (in tons, percentages in brackets):—Siam 43,061 (64.1), Burma 22,073 (32.9), French Indo-China 853 (1.3), other countries 1,150 (1.7).

Of the exports during April, 79 per cent. were consigned to the Netherlands Indies and 21 per cent. to other countries. The various kinds of rice exported were as follows (in tons, percentages in brackets):—Siam 10,310 (67.0), Burma 4,519 (29.4), French Indo-China 439 (2.8), parboiled 39 (0.3), local production 83 (0.5).

India and Burma.—Exports from India during the first quarter of the year totalled 61,000 tons as compared with 525,000 tons in 1937, a decrease of 88.4 per cent. Of these exports 4.9 (4.6) per cent. were to the United Kingdom, 8.2 (7.0) per cent. to the Continent of Europe, 44.3 (26.1) per cent. to Ceylon, 4.9 (26.1) per cent. to the Straits Settlements and the Far East, and 37.7 (36.2) per cent. to other countries. The percentages in brackets are for the corresponding period of 1937.

Burma's exports from the 1st January to 20th April totalled 1,210,474 tons, an increase of 0.6 per cent. when compared with the previous year's figures of 1,202,836 tons. Of these exports 43.4 (47.1 per cent. were to India, 9.1 (8.8) per cent. to the United Kingdom, 7.2 (4.6) per cent. to the Continent of Europe, 11.4 (11.2) per cent. to Ceylon, 14.0 (13.1) per cent. to the Straits Settlements and the Far East, and 14.9 (15.2) per cent to other countries. The percentages in brackets are for 1937.

Siam.—Exports of rice and rice products from Bangkok during February were 153,451 tons, as compared with 119,456 tons in 1937.

Japan.—The latest information available was published in the February Summary.

French Indo-China.—Entries of padi into Cholon during the first four months of the year totalled 518,565 tons as compared with 608,303 tons, a decrease of 14.8 per cent. Exports of rice during the same period were 494,319 tons as compared with 526,499 tons in 1937, a decrease of 6.1 per cent.

The Netherlands Indies.—The latest information available was published in the March Summary.

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* Abridged from the Rice Summary for April 1938 compiled by the Department of Statistics, Straits Settlements and Federated Malay States.

† Ton = long ton (2,240 lbs.)

¶ It is to be understood throughout the summary that all comparisons and percentage increases or decreases are in relation to the corresponding period of 1937.

Ceylon.—Imports during the first four months of the year totalled 183,572 tons as compared with 182,567 tons in 1937, an increase of 0.6 per cent. Of these imports 15.6 (16.1) per cent. were from British India, 73.6 (71.6) per cent. from Burma, 0.5 (0.2) per cent. from the Straits Settlements, and 10.3 (12.1) per cent. from other countries. The percentages in brackets are for 1937.

Europe and America.—Shipments from the East to Europe from the 1st January to 8th April totalled 307,713 tons as compared with 334,733 tons in 1937, a decrease of 8.1 per cent. Of these shipments 56.9 (48.8) per cent. were from Burma, 33.2 (38.4) per cent. from Saigon, 7.2 (8.8) per cent. from Siam and 2.7 (4.0) per cent. from Bengal. The 1937 percentages are in brackets.

Shipments for the Levant from the 1st January to 7th April were 6,610 tons as compared with 4,587 tons in 1937, an increase of 44.1 per cent. Shipments for Cuba, West Indies and America from 1st January to 28th March totalled 60,628 tons, a decrease of 15.3 per cent. when compared with the 1937 shipments of 71,607 tons.

MALAYAN AGRICULTURAL EXPORTS, APRIL, 1938.

PRODUCT.	Net Exports in Tons				
	Year 1937	Jan./April 1937	Jan./April 1938	April 1937	April 1938
Arecanuts ...	30,084	11,767	13,977	3,251	2,646
Coconuts fresh † ...	95,223†	26,830†	30,183†	9,098†	7,438†
Coconut oil ...	39,762	11,671	14,515	3,217	3,010
Copra ...	75,592	17,519	12,442	1,395	2,302
Gambier, all kinds ...	1,955	677	509	153	84
Copra cake ...	15,026§	4,391§	2,088	774	485
Palm kernels ...	7,312	2,015	2,785	445	609
Palm oil ...	42,787	13,155	16,515	4,020	3,565
Pineapples canned ...	80,502	27,652	26,908	8,581	6,697
Rubber ¶ ...	503,127¶	146,196¶	135,968¶	33,085¶	27,603¶
Sago,—flour ...	15,478	8,264	2,132	1,473	388*
,, —pearl ...	3,759	1,118	1,375	237	413
,, —raw ...	8,256*	2,560	2,332*	625*	622*
Tapioca,—flake ...	1,058	411	320	88	74
,, —flour ...	2,393*	953*	1,262*	452*	404*
,, —pearl ...	18,786	5,382	5,232	1,679	1,162
Tuba root ...	573	214	131	38	51

† hundreds in number. * net imports. ¶ production. § gross exports.

MALAYAN PRODUCTION OF PALM OIL AND KERNELS

(In long tons, as declared by Estates)

Month 1938	Palm Oil		Palm Kernels	
	F.M.S.	U.M.S.	F.M.S.	U.M.S
January	2,241.7	1,309.2	383.7	232.0
February	2,040.4	1,457.1	370.4	261.0
March ...	2,359.6	1,843.1	446.8	344.0
April	1,963.7	1,122.6	353.6	218.0
Total ...	8,605.4	5,732.0	1,554.5	1,055.0
Total January to April, 1937	7,115.9	5,427.4	1,350.7	946.8
Total for the year 1937 ...	27,733.5	17,932.8	5,094.7	2,811.4

Stocks on estates as at 30th April, 1938 were: palm oil 1,985 tons, palm kernels 536 tons.

MALAYAN RUBBER STATISTICS

Acreages of Tappable Rubber actually Tapped and not Tapped on Estates of 100 Acres and over, for the Month ending 30th April, 1938.

State or Territory	Estimated Acreages of Tappable Rubber	Actual area tapped during the month Acreage	Percentage of (3) to (2)	Acreages of tappable rubber not tapped: Estates which have entirely ceased tapping — Acreage	Percentage of (5) to (2)	On estates which have partly ceased tapping: Otherwise than under rotational systems — Acreage	Percentage of (7) to (2)	Under rotational systems — Acreage	Percentage of (9) to (2)	Area of Tappable Rubber never been tapped — Acreage	Percentage of (11) to (2)	Total area not tapped (5) + (7) + (9)	Percentage of (13) to (2)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
S. S.—													
Province Wellesley ...	43,386	22,569	52.0	2,380	5.5	9,800	22.6	8,637	19.9	403	0.9	20,817	48.0
Malacca ...	122,504	69,840	57.0	2,319	1.9	20,558	16.8	29,787	24.3	2,066	1.7	52,664	43.0
Penang ...	2,488	1,311	52.7	258	10.4	859	34.5	60	2.4	36	1.4	1,177	47.3
Singapore ...	32,381	18,299	56.5	2,921	9.0	6,471	20.0	4,690	14.5	103	0.3	14,082	43.5
Total S.S. ...	200,759	112,019	55.8	7,878	3.9	37,688	18.8	43,174	21.5	2,608	1.3	88,740	44.2
F. M. S.—													
Perak ...	288,356	178,723	62.0	3,276	1.1	51,590	17.9	54,767	19.0	7,384	2.6	109,633	38.0
Selangor ...	327,521	219,883	67.1	7,161	2.2	38,532	11.8	61,945	18.9	6,377	1.9	107,638	32.9
Negri Sembilan ...	254,238	161,060	63.4	6,768	2.7	35,709	14.0	50,701	19.9	7,582	3.0	93,178	36.6
Pahang ...	86,199	55,432	64.3	2,814	3.3	18,376	21.3	9,577	11.1	6,982	8.1	30,767	35.7
Total F.M.S. ...	956,314	615,098	64.3	20,019	2.1	144,207	15.1	176,990	18.5	28,325	3.0	341,216	35.7
U. M. S.—													
Johore ...	475,550	319,124	67.1	5,493	1.2	79,830	16.8	71,103	14.9	34,861	7.3	156,426	32.9
Kedah ...	197,805	130,656	66.1	5,722	2.9	22,369	11.3	39,058	19.7	6,901	3.5	67,149	33.9
Kelantan ...	31,230	21,689	69.4	243	0.8	5,317	17.0	3,981	12.8	2,182	7.0	9,541	30.6
Trengganu (*b*) ...	4,817	3,143	65.3	nil	nil	74	1.5	1,600	33.2	74	1.5	1,674	34.7
Perlis (*c*) ...	1,371	858	62.6	216	15.8	257	18.7	40	2.9	84	6.1	513	37.4
Brunei ...	5,417	1,809	33.4	nil	nil	2,730	50.4	878	16.2	556	10.3	3,608	66.6
Total U.M.S. ...	716,190	477,279	66.6	11,674	1.6	110,577	15.5	116,660	16.3	44,658	6.2	238,911	33.4
Total Malaya ...	1,873,263	1,204,396	64.3	39,571	2.1	292,472	15.6	336,824	18.0	75,591	4.0	668,867	35.7

Notes:—(*a*) The acreage shown in column (11) is included in columns (5) and (7).
(*b*) Registered companies only.
(*c*) Rendered quarterly.

MALAYAN RUBBER STATISTICS — TABLE I

STOCKS, PRODUCTION, IMPORTS AND EXPORTS OF RUBBER, INCLUDING LATEX, CONCENTRATED LATEX AND REVERTEX

FOR THE MONTH OF APRIL, 1938 IN DRY TONS.

State or Territory	Stocks at beginning of month 1			Production by Estates of 100 acres and over		Production by Estates of less than 100 acres estimated 2		Imports				Exports including re-exports				Stocks at end of month			Consumption 3	
								during the month		January to April 1938		during the month		January to April 1938						
	Ports	Dealers	Estates of 100 acres and over	during the month	Jan. to April 1938	during the month	Jan. to April 1938	Foreign	From Malay States & Labuan	Foreign	From Malay States & Labuan	Foreign	Local	Foreign	Local	Ports	Dealers	Estates of 100 acres and over	during the month	Jan. to April 1938
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
MALAY STATES :—																				
Federated Malay States ...	...	10,528	14,310	10,428	47,008	4,738	22,705	Nil	Nil	Nil	Nil	14,953	1,911	54,765	14,911	...	9,034	14,092	14	58
Johore ...	...	4,703	5,389	4,798	21,622	1,438	12,402	Nil	10	Nil	95	3,436	3,429	13,425	20,855	...	3,615	5,858	...	...
Kedah ...	...	298	3,645	2,579	11,808	709	3,636	Nil	Nil	Nil	Nil	1,840	1,414	8,043	7,552	...	345	3,632	...	...
Perlis ...	...	12	23	13	57	20	88	Nil	Nil	Nil	Nil	Nil	22	Nil	124	...	23	23	...	...
Kelantan ...	...	1,035	228	341	1,415	197	2,299	Nil	Nil	Nil	Nil	313	481	1,034	2,759	...	672	335	...	...
Trengganu ...	...	55	50	193	1,114	96	557	Nil	Nil	Nil	Nil	Nil	289	Nil	1,671	...	55	50	...	...
Brunei ...	...	Nil	69	19	181	31	259	...	...	...	...	...	58	...	454	...	6	55	...	...
Total Malay States	...	16,631	23,714	18,371	83,205	7,229	41,945	Nil	10	Nil	95	20,542	7,604	77,267	48,326	...	13,750	24,045	14	58
S. SETTLEMENTS :—																				
Malacca ...	...	2,444	1,433	1,069	4,780	157	2,093	Nil		Nil		2,650		10,380		...	2,498	1,434	...	...
Province Wellesley ...	...	3,244	727	404	1,727	89	832	Nil		Nil		8,312		33,230		...	2,287	657	...	...
Penang ...	2,817	6,212	10	15	79	16	350	1,566	10,618	8,798	52,831		Nil		Nil	2,405	4,953	12	...	...
Singapore ...	9,058	32,727	226	145	654	18	253	7,543		44,926		22,360		79,069		4,798	28,472	282	27	100
Labuan ...	...	44	Nil	Nil	Nil	Nil	50	49		199		Nil		Nil		...	43	Nil	...	...
Total Straits Settlements ...	11,875	44,671	2,396	1,633	7,240	280	3,578	9,158	10,618	53,923	52,831	33,322	Nil	122,679	Nil	7,203	38,253	2,385	27	100
Total Malaya ...	11,875	61,302	25,110	20,004	90,445	7,509	45,523	9,158	10,628	53,923	52,926	53,864	7,604	199,946	48,326	7,203	52,003	26,430	41	158

TABLE II
DEALERS' STOCKS, IN DRY TONS 3

Class of Rubber	Federated Malay States	S'pore	Penang	Province We'sly D'dings M'cca.	Johore	Kedah
22	23	24	25	26	27	28
DRY RUBBER	8,015	27,491	4,845	4,494	2,951	140
WET RUBBER	1,019	981	108	340	664	215
TOTAL ...	9,034	28,472	4,953	4,834	3,615	345

TABLE III
FOREIGN EXPORTS

PORTS	For month	Jan. to Apr 1938
29	30	31
Singapore ...	36,586	132,738
Penang ...	11,824	48,072
Port Swettenham	5,162	18,352
Malacca ...	292	784
MALAYA ...	53,864	199,946

TABLE IV
DOMESTIC EXPORTS 4

AREA	For month	Jan. to Apr 1938
32	33	34
Malay States ...	28,080	125,265
Straits Settlements	2,139	10,499
MALAYA ...	30,219	135,764

Notes:—

1. Stocks on estates of less than 100 acres and stocks in transit on rail, road or local steamer are not ascertained
2. The production of estates of less than 100 acres is estimated from the formula: Production + Imports + Stocks at beginning of month = Exports + Stocks at end of month, + Consumption, *i.e.*, Column [7] = Columns [13] + [14] + [17] + [18] + [19] + [20] − [2] − [3] − [4] − [5] − [9] − [10]. For the Straits Settlements the production of estates of less than 100 acres is represented by sales or exports as shown by cess paid.
3. Dealers' stocks in the Federated Malay States are reduced to dry weights by the following fixed ratios: unsmoked sheet, 15% wet sheet, 25% scrap, lump, etc., 40%; stocks elsewhere are in dry weights as reported by the dealers themselves.
4. Columns (33) and (34) represent exports of rubber subject to regulation which, for Singapore and Penang Islands are represented by sales or exports as shown by cess paid.
5. All statements are brought up to date monthly, and any inaccuracies that may be disclosed are corrected in the totals; the latest publication therefore, is always the most reliable.
6. The above, with certain omissions, is the Report published by the Registrar-General of Statistics, S.S and F.M.S., at Singapore on 24th May, 1938.

METEOROLOGICAL SUMMARY, MALAYA, APRIL, 1938.

Locality.	Air Temperature in degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine.		
	Means of			Absolute Extremes						Total.		Most in a day.	Number of days.					Total.	Daily Mean.	Per cent.
	A. Max.	B. Min.	Mean of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot	At 4 feet			Amt.	Precipitation .01 in or more	Precipitation, .04 in or more	Thunder-storm	Fog morning obs.	Gale force 8 or more			
	°F	°F	°F	°F	°F	°F	°F	°F	°F	in.	mm.	in.						hrs.	hrs.	
Railway Hill, Kuala Lumpur, Selangor ...	91.2	73.4	82.3	93	71	87	76	85.3	85.6	6.20	157.5	0.97	20	19	5	14	2	182.55	6.09	50
Bukit Jeram, Selangor ...	89.5	73.3	81.4	93	71	85	75	85.6	87.3	11.33	287.8	2.87	19	18	6		1	234.40	7.81	64
Sitiawan, Perak ...	89.6	74.4	82.0	92	72	87	77	85.2	85.3	4.76	120.9	1.15	20	15	1	1		226.85	7.56	62
Ipoh Aerodrome, Perak ...	90.9	73.5	82.2	95	71	85	75	84.4	84.9	12.44	316.0	1.40	24	24	11	1		200.70	6.69	55
Temerloh, Pahang ...	90.6	73.6	82.1	94	71	85	75	87.3	86.9	5.61	142.5	2.18	15	9	2	6		181.55	6.05	49
Kuala Lipis, Pahang ...	91.0	72.7	81.9	94	70	88	75	85.3	85.2	4.94	125.5	2.33	23	16	3	19		191.70	6.39	52
Kuala Pahang, Pahang ...	87.5	75.8	81.7	89	74	85	80	86.3	87.2	12.03	305.6	4.06	19	12	4			241.90	8.06	66
Kallang Aerodrome, S'pore ...	86.7	75.7	81.2	90	73	82	78	82.9	83.5	8.81	223.8	2.07	20	16	8		1	162.25	5.41	44
Bayan Lepas Aerodrome Penang ...	88.0	74.9	81.5	91	72	84	78	85.0	85.1	12.10	307.3	1.62	26	22	15			220.25	7.34	60
Bukit China, Malacca ...	86.6	74.4	80.5	91	72	81	77	83.8	84.8	7.44	189.0	1.69	21	19	10	1	1	200.65	6.69	55
Kluang, Johore ...	89.8	72.3	81.1	93	70	82	74	82.8	82.6	7.66	194.6	1.21	23	19	9	15		181.05	6.03	49
Bukit Lalang, Mersing, Johore	87.8	73.1	80.5	91	71	85	79	83.1	82.2	7.15	181.6	1.68	15	14	4		1	213.00	7.10	59
Alor Star, Kedah ...	89.7	74.6	82.1	93	72	85	77	85.4	86.2	18.36	446.3	4.12	19	17	5		1	228.80	7.63	63
Kota Bahru, Kelantan ...	89.9	74.5	82.2	93	73	84	77	85.4	84.7	1.23	31.2	0.54	8	6				260.05	8.67	71
Kuala Trengganu, Trengganu	88.9	73.9	81.4	92	72	87	79	85.2	85.1	0.62	15.7	0.31	6	3		3		260.40	8.68	71
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft.	74.6	63.4	69.0	78	62	71	65	72.9	72.6	11.91	302.5	2.35	27	24	6	15	1	145.75	4.86	40
Cameron Highlands, Tanah Rata, Pahang 4750 ft. ...	73.8	58.8	66.3	77	53	70	64	71.3	70.5	11.14	283.0	1.55	26	24	2			148.85	4.96	40
Cameron Highlands, Rhododendron Hill, Pahang 5120 ft. ...	73.4	61.0	67.2	77	59	68	62			11.36	288.5	1.64	25	24				162.40	5.41	44

Compiled from Returns supplied by the Meteorological Department, Malaya.